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Song's Site at Los Angeles Eco-Village Redevelopment

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Loyola Marymount University
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Song's Site at Los Angeles Eco-Village Redevelopment

A thesis submitted in partial satisfaction

of the requirements of the University Honors Program

of Loyola Marymount University

by

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SONG'S AT LAEV REDEVELOPMENT

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ECOLIONS ENGINEERING

April 28, 2023

Prof. Joseph C. Reichenberger and Dr. Negin Tauberg
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Subject: LA Ecovillage

Prof. Reichenberger and Dr. Tauberg,

In response to your request, Eco-Lions Engineering is pleased to present the design package for the site of the recently acquired "Songs at LAEV" site located at the corner of West 1st Street and Bimini Place in Los Angeles, CA. Enclosed in this report is the initial CEQA study, and design procedures for the site's learning garden and garden structure, an updated aquaponics system, and a rainwater collection and use system design for the existing structure. Relevant design calculations and a preliminary cost estimate are also included with this report.

Please do not hesitate to contact us with any questions, comments, or concerns.

Sincerely,

ECOLIONS ENGINEERING

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Kristin Hernandez, E.I.T.

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INTRODUCTION

1.1. Background

The Los Angeles Eco-Village (LAEV) is a 40-tenant co-op housing community focused on sustainable and economic cooperative living. The community consists of the two blocks of Bimini and White House Place located in the north end of the Wilshire Center area of Los Angeles. In 2016, CRSP, the nonprofit developer of the LAEV, acquired a quarter acre property known as Songs, formerly an auto shop, on the north end of the neighborhood. The property is classified as a Brownfield and significant work has already been done to address soil remediation and retrofit of the existing auto shop structure. The LAEV wishes to transform and redevelop this new acquisition into a thriving multipurpose community hub for tenants and visitors seeking to learn about sustainable urban living.

1.2. Community Design Plans

Eco-Lions Engineering met with LAEV founder Lois Arkin, and several community members during initial stages of the project to tour the LAEV and discuss their objectives for redevelopment and improvement of the Eco-Village properties. Because the site was previously an auto-shop, the site is currently undergoing soil remediation testing. In the future, the asphalt and concrete paving plan to be removed to remediate the soil underneath. This will remain unpaved post-remediation. The LAEV also plans to demolish the west building, a vacant restaurant, and turn the space into a diversity garden. This would include vegetation representative of the various cultural backgrounds of community members. The most immediate discussion point was to include an improved learning garden area around existing storage space in the southeast tail of the site, to educate beginners on the basics of urban agricultural gardening. Additional ideas included a retrofit of the existing Song's auto-shop into a community hub, an expansion of the existing aquaponics system, the addition of an eco-hostel building, and the implementation of sustainable runoff harvesting practices.

1.3. Community Objectives

Based upon community input, four goals were established for the project design:

1. The design should cultivate new, highly sustainable, and resilient ideas on urban living.
2. The design should incorporate educational elements to inspire visitors and tenants to live more sustainably.
3. The project should fit within the schedule and scope of the existing community plans.
4. The design should minimize costs.

In a follow up meeting, Eco-Lions Engineering and LAEV selected to redevelop portions of the Song's site because it has the most potential to meet the project design goals. These goals have been incorporated into each element of the project design. The project team has continued to be in close contact with several members of the LAEV, who have provided feedback on preliminary reports and continue to have a working relationship with Eco-Lions Engineering.

1.4. Project Description

Eco-Lions engineering proposes three design elements to improve the community use of the newly acquired Songs at LAEV site:

1. Learning garden and education center.
2. Rainwater collection, storage, and use.
3. Improved aquaponics system.

The area on the Southeast portion of the site has been reimagined and designed as a 'Learning Garden' to be equipped with a 120 square foot structure that serves as a multi-purpose Garden Education Center. The Los Angeles Eco-Village provides tours for members of the public who are interested in learning more about cooperative and ecological living to fulfill the mission of educating others on sustainable urban living through urban food gardening and permaculture. The proposed Learning Garden space will aim to satisfy LAEV's expressed interest in developing a garden space with potential for community engagement and learning opportunity. The Learning Garden and Garden Education Center could be used to educate the public on sustainable gardening techniques that could be implemented in small, urban spaces. The space can be used to host introductory planting lessons, provide a space for small tour groups to meet before touring the site, or be used as a space to store gardening equipment such as seedling trays.

This design proposal also includes a rainwater collection, storage, and use system for the site. It is the goal of the client to collect and use as much on-site runoff as possible in order to improve the sustainable practices of the community. Harvesting on-site runoff for non-potable uses is a resilient and accessible practice, and it is a goal of the community to maximize collection and use on site while inspiring visitors and other members of the community to adopt similar practices. Rainwater harvesting benefits the community economically by reducing water use and environmentally by reducing the carbon footprint of the community and keeping the gardens and soil healthy year-round. This proposal will summarize runoff volumes for the site according to the City of LA Low Impact Development requirements and propose an easily implemented design for roof runoff collection, storage, and use.

The current aquaponics system, shown in Figure 6 later in this report, serves as an additional source of produce for the community, and is used to educate and inspire visitors to try constructing their own aquaponics systems. Eco-lions engineering proposes an expanded system to include live fish as the source of nutrients and the growing space expanded by implementing a stacked media bed design. The new system is designed to include production of microgreens per the suggestion of the community. With two media bed layers dedicated to microgreen production, the community can not only benefit from nutrient-rich, rapid harvests but also profit due to the high microgreen demand in the culinary industry. The shallow bed depth of microgreens also allows for less system head loss, and a more efficient pump design. Additional benefits of microgreens will be elaborated further in this report. The top media bed was sized for full-size fruit and vegetable growth, so the community has the opportunity to continue growing the seasonal species they plan to grow with their current system.

1.5. Site Description

Songs at LAEV is located at 3554 and 3560 West 1st Street in the City of Los Angeles, California as shown in Figure 1. The trapezoidal shaped lot is bordered by West 1st street, Bimini Place, the Los Angeles Eco-Village main building, and a commercial zoned area as illustrated by the red boundary line in Figure 1. The site coordinates are 34°4′22.5″ N Latitude and 118°17′23.8″ W Longitude. The site was formerly used as an auto repair shop, consisting of a one-story block building and associated parking lot, in addition to a separate structure that functioned as a restaurant/cafe prior to recent demolition. Figure 2 in more detail indicates current site features and topography based on the most recent site survey included in Appendix E, and site images shown in Figures 3 through 6.

Figure 1. 2019 Satellite Image of the Current Los Angeles Eco-Village Site with the Songs Site boundary outlined in red.

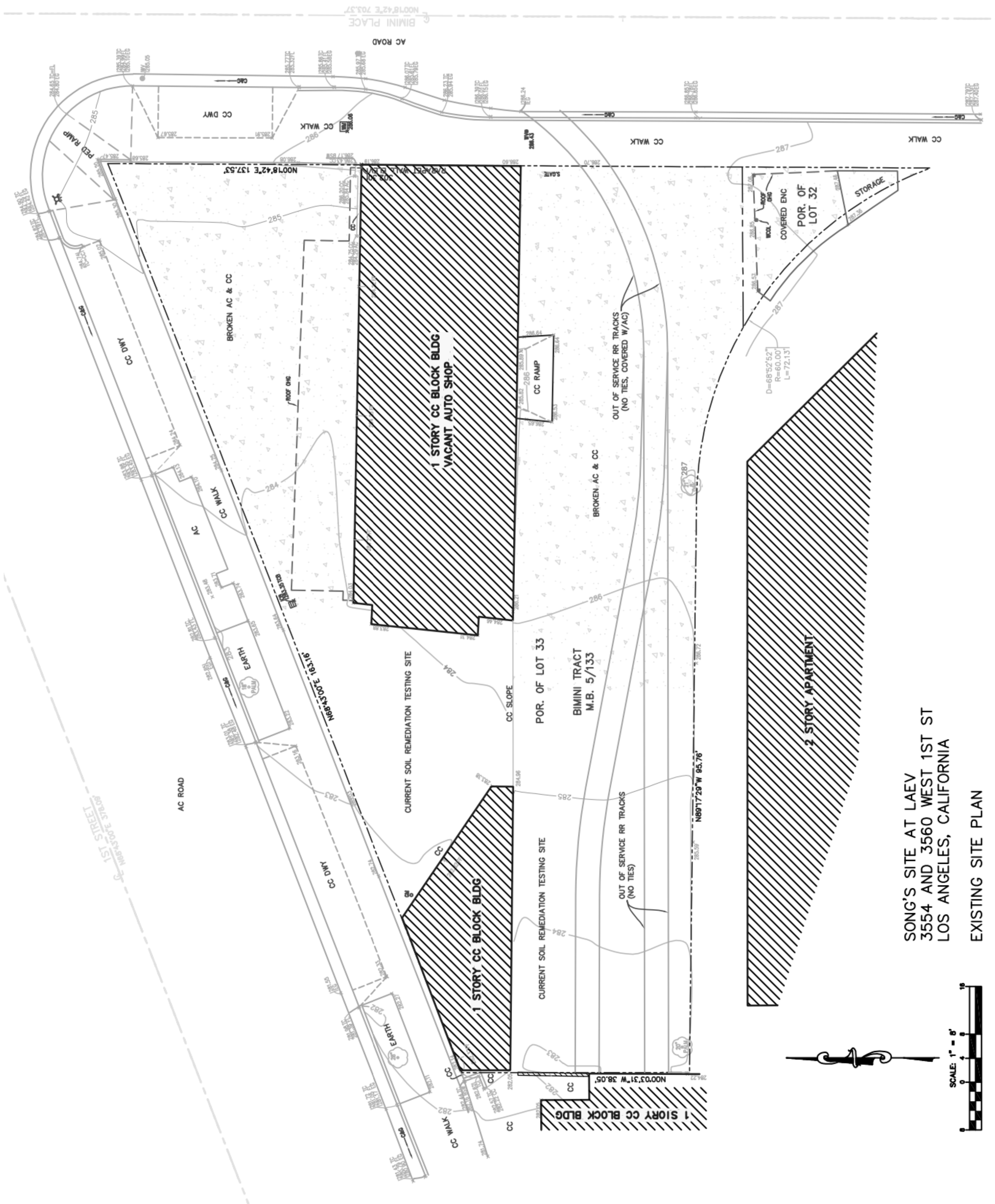

Figure 2. Plan View of Current Site

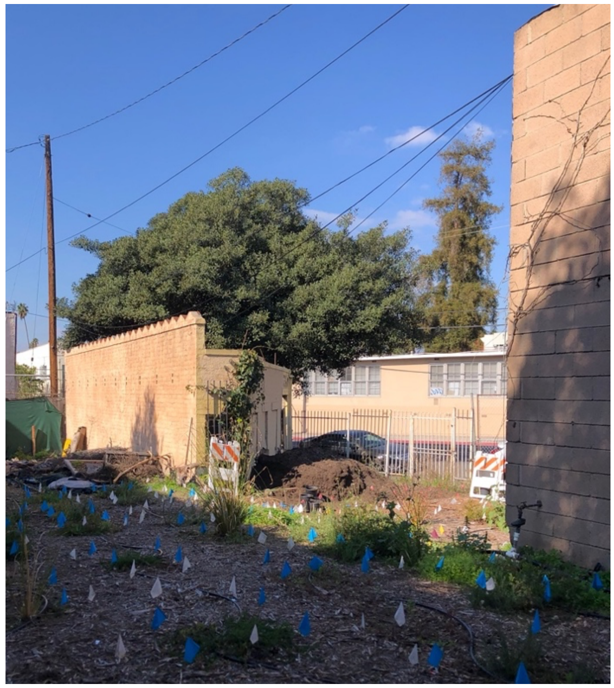

Figure 3. (Left) Image of soil remediation testing site and restaurant structure to be demolished. Taken January 28, 2023.

Figure 4. (Right) Image of South entrance to auto shop and asphalt to be removed. Taken January 28, 2023.

Figure 5. Image of current learning garden area and existing storage shed. Taken January 28, 2023.

Figure 6. Image of current aquaponics system to be redesigned by Eco-Lions Engineering. Taken January 28, 2023.

1.6. Design Criteria and Codes

The Garden Education Center structural design is subject to the Los Angeles Municipal Building Code which references the 2018 International Building Code (IBC) and ASCE 7-16. Songs at LAEV is classified as a C1.5 commercial use building under the Los Angeles Department of City Planning Zoning Regulations, which includes retail buildings with limited manufacturing, service stations and garages, retail business, churches, schools, auto sales, in addition to R4 Uses. There are no setback requirements or minimum areas/lot widths for commercial uses of this zone type. High-rise zoning regulations in relation to building height do not apply to commercial zones of this type. In accordance with the 2021 IBC and 2022 California Building Code (CBC), the building's occupancy is classified as Assembly Group A-3. The Occupancy Classification Group A-3 includes buildings intended for worship, recreation, amusement, and other assembly purposes.

The Song's at LAEV site is subject to the City of Los Angeles Department of Public Works Low Impact Development Manual and the LA Sanitation Low Impact Development Handbook. All stormwater management on site, including the proposed rainwater collection and reuse system, must follow the City of Los Angeles LID Handbook. Specifically, the site redevelopment must comply with the requirements listed under part 2b of Section C of City of Los Angeles Low Impact of Development Ordinance: "Development or Redevelopment resulting in an alteration of less than 50% of the impervious surfaces of an existing developed site, only such incremental developments shall comply with the standards and requirements of this article and with the Development Best Management Practices Handbook." (City of Los Angeles).

PROPOSED PROJECT

2.1. Proposed Site Plan and Assumptions

The Song's at LAEV site is currently a brownfield site undergoing remediation. Eco-Lions Engineering has been informed by the client that all asphalt and concrete will be removed from the site and all soil fully remediated before any of the design elements proposed in this report are implemented. It is assumed that the site will maintain existing grade as much as possible; an estimate of the new rough grade for the area of the demolished building has been included in the proposed site plan in Appendix F. The scope for this project does not include precise grading, drainage, and erosion control for the remediated site. It is assumed these elements will be completed prior to the implementation of the design proposed by Eco-Lions engineering.

The proposed elements included in this design report focus primarily on the Eastern half of the site as seen in the site plan shown in Figure 7. The garden learning center is proposed to be located on the southeast side of the site, allowing room for access to the learning garden and the existing storage shed located on the southeast tail of the site which the community desires to keep for storage purposes. The rainwater collection tanks will be located on the west wall of the auto shop and connect to the existing downspout. The updated aquaponics system will be located on the South wall of the auto shop, in the same location as the current system. Eco-lions Engineering suggests the addition of a pathway, constructed from recycled bricks from the demolition of the restaurant structure to allow for ADA accessibility during site tours.

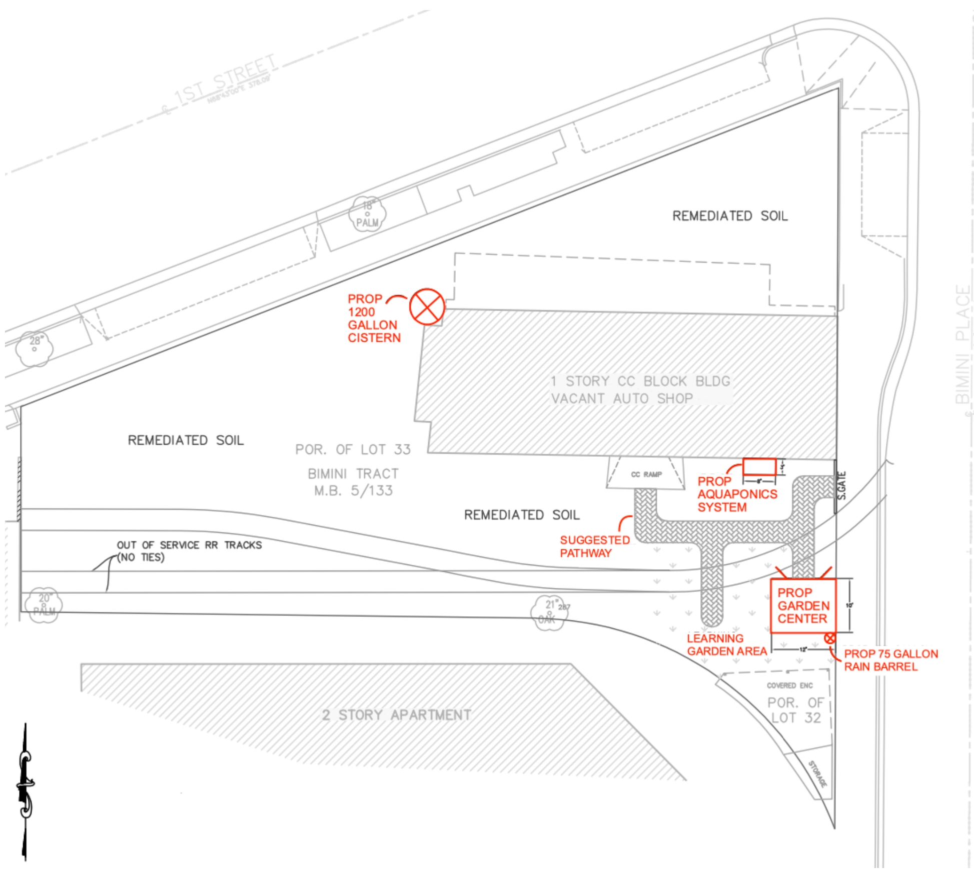

Figure 7. Proposed Site Plan

2.2. Utilities Plan

Current onsite utilities are provided by the city. The scope for this project does not include the replacement or addition of new utilities. The existing plan will be obtained by the client for review. Utilities connections per the most recent site survey are seen in Figure 8. The services required only consist of pump power and lighting connections, which will be conducted by an electrical engineer.

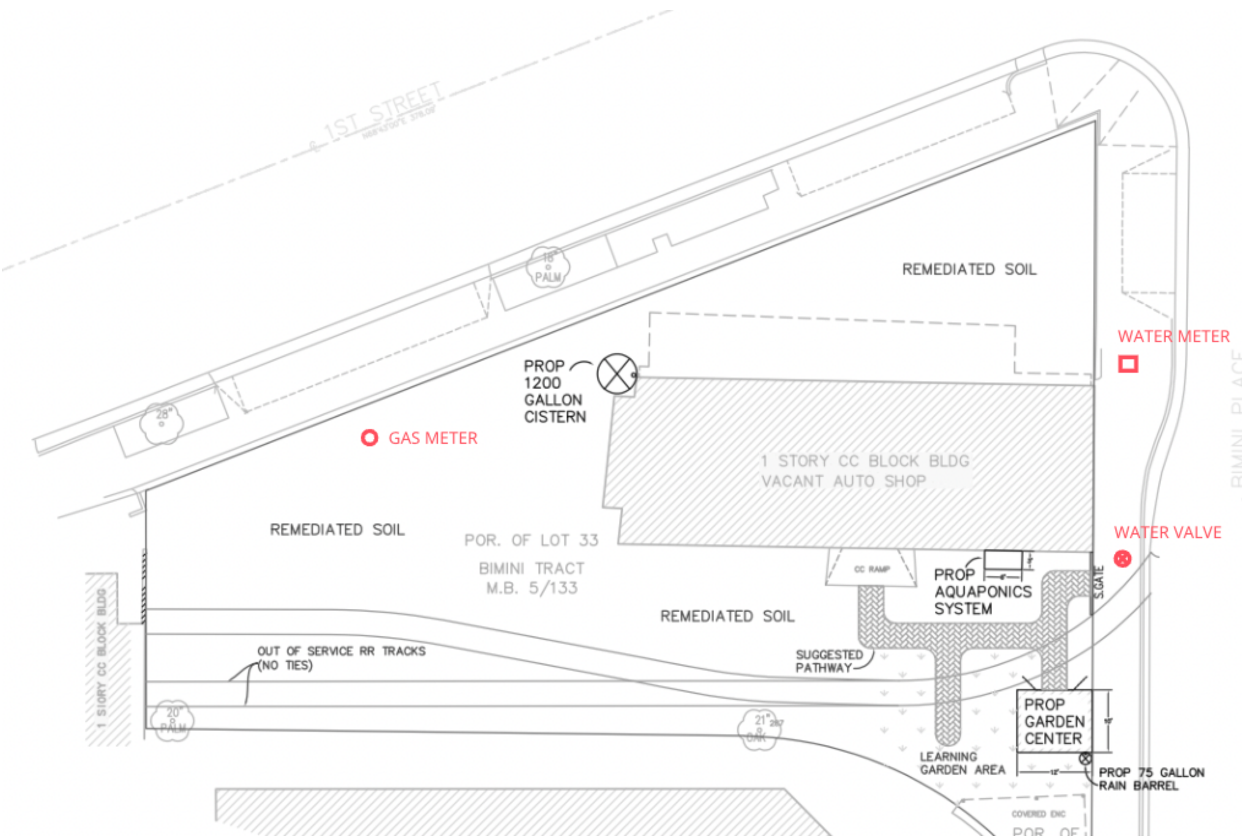

Figure 8. Utilities Connection Locations

2.3. Sustainability Elements

The proposed project expands on existing LAEV site sustainability elements, including:

- Reduced parking footprint, with access to quality transit (bus stops and bike racks).
- On-site Composting.
- Community environmental education.
- Solar panels to be placed on retrofitted auto shop/community hub.
- Aquaponics system.

The Eco-Lions Engineering team utilized these elements and input from the community to incorporate additional sustainable qualities into the project. First, the site is to be left unpaved per community request and follow LID requirements for rainwater recapture, and above ground storage and use. The selection of above-ground storage serves as inspiration for guests to pursue their own rainwater capture systems. The team also left recommendations for future bioswale potential for the pervious areas, with the current grading. Next is the Learning Garden element. This garden can utilize plant species that improve soil quality and permaculture. The garden structure design also offers further opportunity for community learning, as a space for LAEV community members to inform visitors about the site and teach guests the basics of gardening. This both inspires sustainable action and promotes wellness in the surrounding community. The benefits of gardening include ("The Health Benefits of Gardening."):

- Gained confidence with a new developed range of skills.
- Physical activity
- Nutrition

This is especially beneficial for seniors and persons with health conditions or impairments (Gonzalez, Marlen C.). The newly designed aquaponics system provides sustainability aspects as well as the system conserves water, reduces chemical use, and reduces waste. The team also provides recommendations for future projects based upon current design elements, including a vegetable washing station. Finally, "on-site" and recycled materials were selected for the garden structure and aquaponics system media.

2.4. Cost Estimates

Table 1 below shows the total costs for the project. The estimates do not include the cost of site restoration taking place before design implementation, including asphalt and concrete removal, soil remediation, erosion control, and precise grading and drainage. The cost of the Garden Education Center materials and construction is estimated to be around $6500. The total cost of the rainwater collection and storage system is approximately $2500. The improved aquaponics system is estimated to cost

$4,500. Total operations and maintenance for the design elements will cost about $1500.

Table 1. Project Cost Estimate

Category	Total Cost
Structural Costs	$9,250.00
Rainwater Harvest and Use System	$4,250.00
Total Aquaponics Cost	$6,000.00
Sitwork	$3,500.00
Total O&M Cost	$2,500.00
Total Construction Cost	$25,500.00
Total w/ 15% Contingencies	**$30,000.00**

2.5. CEQA Checklist

The information in the table below addresses all project elements with potential environmental impact in regard to geology and soils. All other CEQA checklist items designated as "No Impact" are located in Appendix H.

GEOLOGY AND SOILS	
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:	
ii) Strong seismic ground shaking?	
CEQA Determination:	Argument:
Less Than Significant with Mitigation Incorporated	This site is located within a "Zone 4" area, indicating a "Very High" seismic hazard rating. This quantifies as about a 30% probability of experiencing strong ground shaking. However, all project elements have been designed with seismic bracing in compliance with relevant building code seismic requirements in the event of a disaster, and emergency procedures will be followed.

iii) Seismic-related ground failure, including liquefaction?	
CEQA Determination:	Argument:
Less Than Significant with Mitigation Incorporated	Although the team does not possess a geotechnical report for the site itself, based on Boring Log reports from a site a block away, there is a small likelihood for liquefaction. These reports are located in Appendix M. Figure 9 below confirms that the soil data is within close proximity to the LAEV site. The reports show that there is a perched water table at a depth of 17 feet, but the clayey soil beneath is dry, indicating that the aquifer is relatively deep and not a concern. The average blow count converted from Cal MOD SS to SPT also indicates firm soil. Finally, the site does not fall within a liquefaction zone on the CGS Seismic Hazards Program Map.

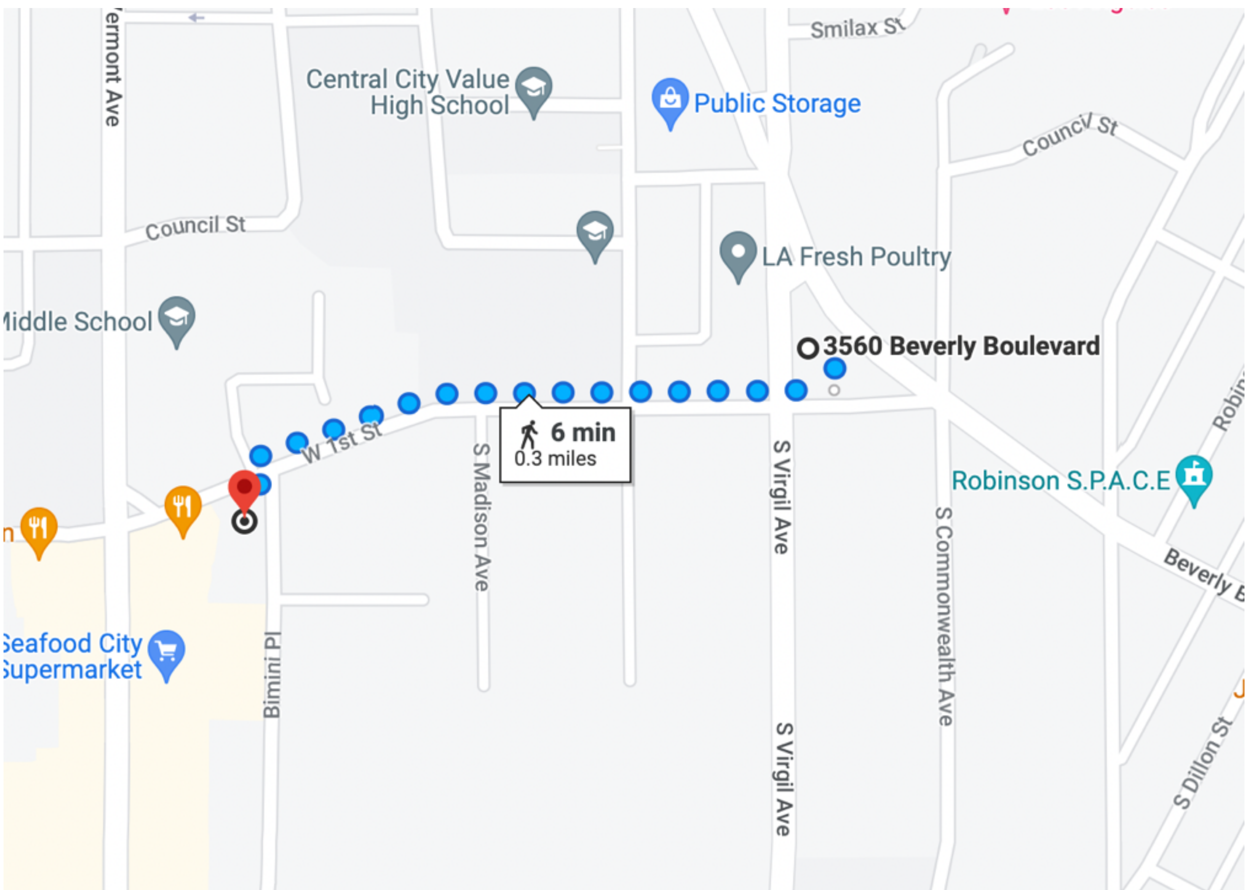

Figure 9. "SONGS at LAEV" to 3560 Beverly Blvd, location of nearing boring log data included in Appendix M.

GEOLOGY AND SOILS CONT.	
c) Be located on a geological unit or soil that is unstable, or would become unstable as a result of the project, and potentially result in on- or off site- landslide, lateral spreading, subsidence, liquefaction, or collapse?	
CEQA Determination:	Argument:
Less Than Significant Impact	Project elements will not impact the stability of the soil on or off site and are designed with appropriate foundation and seismic bracing. The site is also not located on a hillside, therefore there is no cause of concern for landslides. Refer to the Geology and Soils a.i. section for additional soil information regarding liquefaction and other issues.
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial or indirect risks to life or property?	
CEQA Determination:	Argument:
Less Than Significant Impact	Based upon the soil remediation reports provided, the soil type has potential for expansion, however, refer to the Geology and Soils a.i. section for additional soil information on soil stability. It is assumed that any expansive soils would be removed and not incorporated to any fill.

LEARNING GARDEN AND GARDEN STRUCTURE

3.1. Conceptual Design

The Garden Education Center (GEC) structure will be 10 ft x12 ft single-story oriented in the east-west direction, with the longest side facing south. The roof will have a 4:1 slope with a maximum height of 14 ft on the north side and a minimum height of 10 ft on the south side. The roof will have a 1-ft overhang in both the north and south directions, providing a total roof area of 153 square feet. Figure 10 below shows a SketchUp visualization of the structure.

The building is designed to serve the residents of LA Eco-Village and visitors as a shared space to teach the basics of urban agriculture. Occupants of the building can use the space as a welcome center for scheduled tours, to host educational sessions or to store seedlings and newly planted plants. The surrounding area is designed as an outdoor garden space that can be used by residents and visitors for gardening workshops.

Assuming an Occupancy Load Factor of 15 square feet per person and a 120 square foot building, the maximum occupancy of the building is approximately 8 people. The center is designed to comfortably accommodate an intimate group of visitors or residents of the Song's at LAEV site. The maximum occupancy was estimated for Use and Occupancy Classification Group A-3 under IBC guidelines.

Figure 10. Garden Education Center Isometric View (SketchUp)

3.1.1. Layout

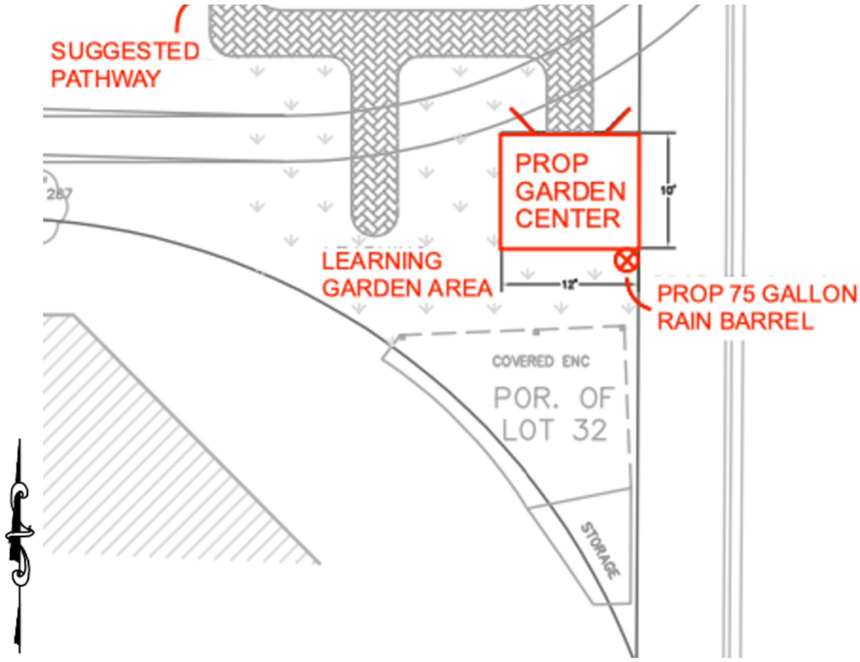

Figure 11. Garden Education Center Location on Site Plan

The Garden Education Center (GEC) will be located on the Southeast side of the site, as shown in Figure 11 above. The center's entrance will be directly to the left of visitors and community members as they enter the site. The location was selected so that the center can immediately orient visitors to the LAEV and provide guidance for their path through the garden. This selection is supported by research on wayfinding in educational settings, like museums. According to Bitgood and Lankford 1995, the initial orientation a visitor receives at the entrance and lobby area is critical for determining their overall experience. The location of the center is also offset from the historic trolley tracks that run east to west on the site. The client requested that the tracks remain undisturbed to allow for future education on the history of Los Angeles public transportation.

The orientation of the structure and roof design were also selected to provide optimum sunlight to the roof for potential solar electricity generation. The client has several solar panels on site that could be installed on the roof of the structure. These panels could be used to generate renewable electricity for the Garden Education Center and other elements of the Learning Garden.

3.2. Structural Materials Selection

The following specifications will govern the methods of construction and material selection used for the construction of the proposed garden education center:

Framing.

Douglas Fir girders, rafters, and studs are proposed as the framing materials for the garden education center. Design values for this material were referenced from the National Design Specifications (NDS) for Wood Design Supplementary Tables. Based on research done by the National Timber Group, Douglas Fir is expected to last well over 35 years. It is also resilient to fungal decay, and it has a high resin content that allows it to maintain its durability over time. The estimated lifespan will accommodate the LAEV's commitment to sustainable living.

Roof Paneling.

Semi-translucent, corrugated polycarbonate sheets are selected as the roofing material for the building. Polycarbonate paneling is selected based on the durability and low cost of maintenance of the material. The paneling will be made from recyclable polycarbonate and can be continued to be used as a construction material after the use of the building. The semi-translucent material will allow solar heat and natural light to enter the building more readily than traditional roofing material, which will help to preserve interior heat without the use of mechanical heating. The selected material will have a thickness of 10 mm (0.394 inches). The dimensions of each panel are 144 inches long x 24 inches wide. Six panels will be used to cover the entire surface of the roof and 1 foot overhang on either side of the North and South edges.

Wall Sheathing.

The material selected for both the shear wall and non-structural wall sheathing is 0.375-inch plywood. Plywood sheathing was selected over OSB for its durability, low maintenance, and ease of installation.

Wall Cladding.

White Oak hardwood is selected as the material for wall siding. A thickness of ½ inch is recommended for the siding. A transparent silicone preservative will be applied to the White Oak in order to protect the wood from moisture, humidity, and UV damage. The silicone surface coating can prevent damage such as splitting and cracking.

Foundation.

The foundation will be made from 4-inch-thick reinforced concrete in accordance with the International Building Code (IBC).

3.3. Roof Drainage Design

The roof of the Garden Education Center is designed to drain precipitation from a 60-minute 100-year storm event, as required by the Los Angeles Plumbing Code and ASCE 7-16. Based on this precipitation intensity and the area of the roof, a 3-inch diameter gutter at a slope of 1/16” per foot of gutter was selected as the primary drainage system from the Los Angeles Plumbing Code 2022. The gutter will be placed on the south side of the roof so water can drain along the 2/5 roof slope into it. The gutter will be sloped from west to east and drain into a cistern placed below as shown in Figure 12. For details on the cistern sizing and downspout connection from the gutter, please see the Rainwater Collection, Storage, and Use section of the report. Precipitation in excess of the amount designed to be captured by the gutter is free to overflow off the edges of the roof. When this is the case, ASCE 7-16 does not require the design of a secondary drainage system, so the roof will not include secondary drains or scuppers.

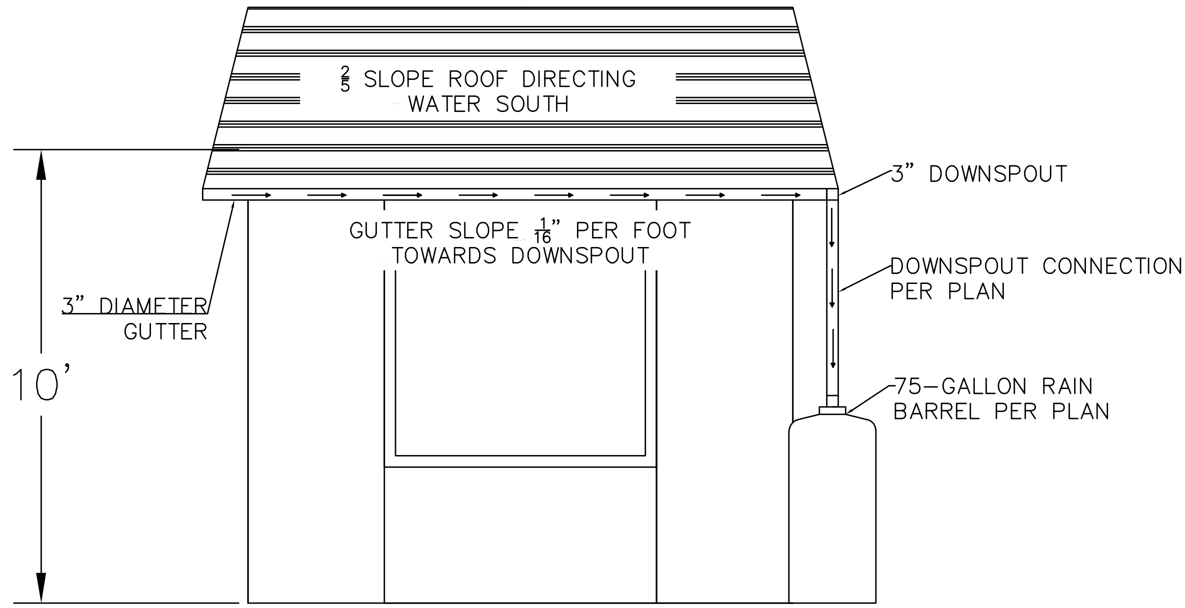

Figure 12. Gutter on Garden Education Center Roof

3.4. Gravity Structural Analysis

The design procedure used to determine the gravity loads acting on the Garden Education Center and size the members of the roof and walls are as follows:

1. Make material selection and determine preliminary structural member dimensions based on conceptual design.
2. Determine dead, live, wind, seismic, snow, and rain loads per ASCE 7-16.
3. Check member capacities such as shear, bending, axial compression and deflection per LRFD and NDS regulations.
4. Compare member capacity to member demand.
5. Resize members if necessary.

3.4.1. Design Loads

The Garden Education Center Structure shall be designed using ASCE 7-16 load combinations for strength design (LRFD). The maximum LRFD load will be used for the design of gravity load carrying members. Brief descriptions of how each of the LRFD loads on the structure were determined are provided below. For more detailed information on how each of the loads were calculated, see Appendix A.

Table 2. Design Loads Summary

Load Summary Weight (psf)	
Dead (D)	13.5
Live (L)	0
Roof Live (Lr)	19.2
Rain (R)	0
Snow (S)	0
Wind (W)	11.97
Seismic (Ev)	4.37
Seismic (Eh)	8.14
Seismic (Emh)	18.78
Seismic (Em)	14.41

Table 3. LRFD Load Combinations

LRFD Load Combinations per ASCE 7-16	Roof (psf)
1.4D	18.9
1.2D+1.6L+0.5Lr	25.8
1.2D+1.6L+0.5S	16.2
1.2D+1.6L+0.5R	16.2
1.2D+1.6Lr+L	46.92
1.2D+1.6S+L	16.2
1.2D+1.6R+L	16.2
1.2D+1.6Lr+0.5W	52.90
1.2D+1.6S+0.5W	22.18
1.2D+1.6R+0.5W	22.18
1.2D+W+L+0.5Lr	37.77
1.2D+W+L+0.5S	28.17
1.2D+W+L+0.5R	28.17
0.9D+W	24.12
1.2D+Ev+Eh+L+0.2S	31.06
0.9D-Ev+Eh	18.27
1.2D+Ev+Emh+L+0.2S	44.78
0.9D-Ev+Emh	32.00
Maximum Load Combination	53

Dead Loads.

The loads considered for roof dead load were the polycarbonate paneling, framing self-weight for wood girders and rafters, utilities/lights, and solar panels. Dead loads were determined using ASCE 7-16 and research on typical weights of the listed materials. The maximum roof dead load was determined by summing up the dead loads acting on the roof. The dead load on the roof was determined to be 13.5 psf as shown in Table 4.

Table 4. Dead Load on Roof

Roof Dead Load	
Material Type	*Weight (psf)*
Roof Paneling	1.93
Girders	1.5
Rafters	6
Utilities/Lights	2
Solar Panels	2
Total	13.43
Rounded Total	13.5

Live Loads.

The Garden Education Center is a single-story structure, so the live loads consist only of the live load on the roof. The live load is 20 psf and can be reduced according to the tributary area of the roof rafters and slope of the roof, as permitted by ASCE 7-16.

Rain Loads.

The secondary drainage system for the roof of the Garden Education Center is free to overflow off the roof's edges. This means that the static head of water on the roof is negligible. For this roof design, ASCE 7-16 allows for the assumption that the hydraulic head on the roof is negligible, given that the length of free edge drainage is greater than the roof flow rate divided by 400. The Garden Education Center roof design meets this criterion for the 3.2 gpm roof flow rate, so the hydraulic head is assumed to be negligible. Since the roof will not have static or hydraulic head of water during a storm event, the rain load on the roof was determined to be 0 psf.

Snow Loads.

The ground snow load for the Los Angeles area is 0 psf per ASCE 7-16. This means that the snow load on the roof of the structure will also be 0 psf.

Wind Loads.

The wind loads on the Garden Education Center were determined using the directional procedure for wind loads on the main wind force resisting system (MWFRS) in ASCE 7-16. This procedure is applicable for enclosed buildings of all heights, which the Garden Education Center fits into. The wind loads were analyzed in both the east-west and north-south directions on the MWFRS walls and roof. The wind design parameters, based on ASCE 7-16 chapter 26, are shown in Table 5, and the wind pressures on the MWFRS are shown in Table 6.

Table 5. Wind Design Parameters.

Wind Design Parameters	
Exposure Category	B
Elevation (ft)	286
Maximum Structure Height (ft)	14
V (mph)	88
Ke	1
Kd	0.85
Kz for h=0-15'	0.57
Kzt	1
qi=0.00256KzKdKeKztV^2	9.6

Table 6. MWFRS Wind Pressures.

MWFRS Wind Pressures			
N-S Direction (psf)		*E-W Direction (psf)*	
Walls, Windward, h=0-14'	8.3	*Walls, Windward, h=0-14'*	8.3
Walls, Leeward	-2.4	*Walls, Leeward*	-5.5
Walls, Sidewalls	-4.0	*Walls, Sidewalls*	-7.4
Roof, Windward	-6.9	*Roof, Windward, 0'-7'*	-12.0
Roof, Leeward	-6.6	*Roof, Windward, 7'-14'*	-7.4

Seismic Loads.

The seismic load effects on the structure were determined using a seismic base shear analysis per the ELF procedure in ASCE 7-16 chapter 12. Since the site does not have a soils report, it was conservatively assumed to be site class D. The seismic design parameters, summarized in Table 7 were determined based on the default values for this site class and ATC Hazards website for the site location. Based on these parameters the SDC is category D.

Table 7. Seismic Design Parameters

Seismic Design Parameters	
Building Occupancy Risk Category	I
I_e	1
Site Class	D
S_s	2.02
S_1	0.72
F_a	1.2
F_v	1.7
S_{ms}	2.43
S_{m1}	1.23
S_{DS}	1.62

S_{D1}	0.82
T_L (s)	8
SDC	D

The seismic weight of the structure was iteratively calculated as the members were sized. The final seismic weight was used to determine the seismic base shear. Per chapter 11 of ASCE 7-16 the seismic base shear must be increased by a factor of 1.5 when using site class D as the default.

Table 8. Seismic Base Shear.

Seismic Base Shear Analysis per ELF	
Governing C_s	0.25
Seismic Weight (k)	3.31
Base Shear (k)	0.82
Adjusted Base Shear for Default Site Class (k)	1.24

To resist the seismic loads on the structure, a seismic force resisting system (SFRS) of light frame wood walls sheathed with wood structural panels (A15 in ASCE 7-16) was selected. This SFRS has a response modification factor of 6.5. The horizontal seismic load effect was determined based on the effect of horizontal seismic forces, from the base shear, and the redundancy factor of 1.3 required by the seismic design category. The vertical seismic load effect was determined based on the dead load and design spectral response acceleration at short periods. These effects were used to calculate the LRFD load combinations and are summarized in Table 9.

Table 9. SFRS and Seismic Load Effects.

Seismic Load Effects and Combinations	
SFRS	A15
E_v (psf)	4.37
E_h (psf)	8.14
E_{mh} (psf)	18.78
E_m (psf)	14.41

3.4.2. Structural Framing Design

The structural member sizing of the Garden Education Center is summarized in Table 10 below. The detailed calculations based on the maximum factored LRFD load combinations are shown in Appendix A.

Table 10. Structural Framing Material and Sizing

Framing Material Selection	
Member	*Material Selection*
Roof Rafters	2x6 No. 1 Douglas Fir
Roof Girders	4x10 No. 1 Douglas Fir
Wall Studs	2x6 No. 1 Douglas Fir
Roof Studs	2x6 No. 1 Douglas Fir
Floor Joists	2x6 No. 1 Douglas Fir

The member sizing and spacing of the structural framing system is shown in the following elevation views. Note that this system does not include elements designed to resist lateral forces such as collectors and shear walls, which will be discussed later.

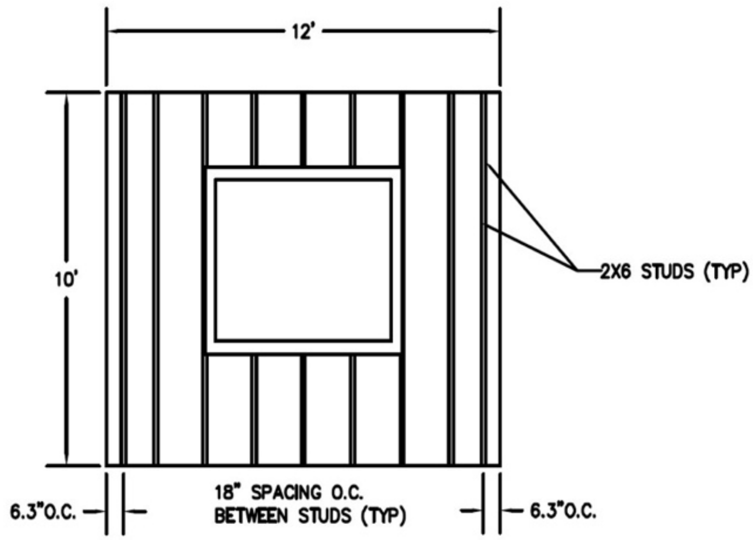

Figure 13. Framing Plan for South Wall.

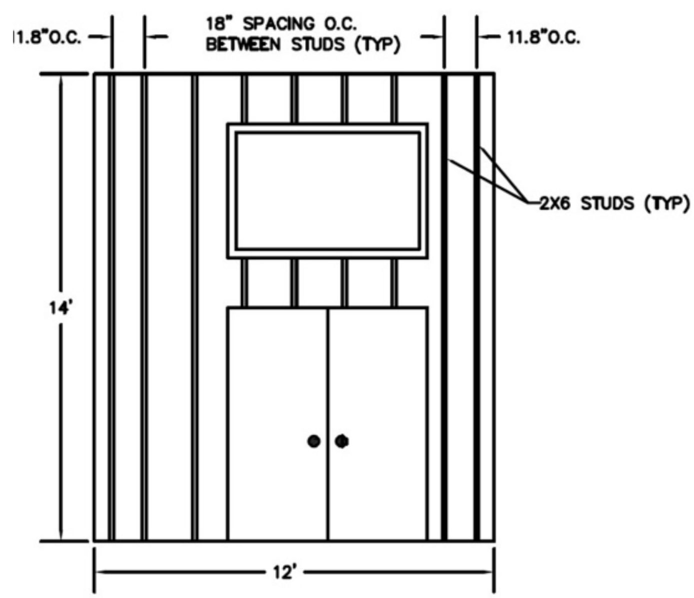

Figure 14. Framing Plan for North Wall.

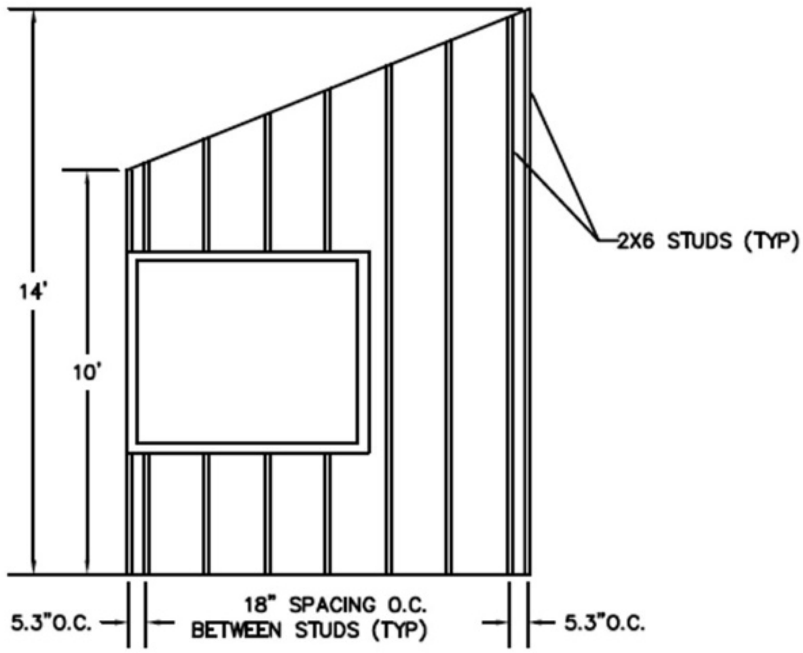

Figure 15. Framing Plan for East/West Walls

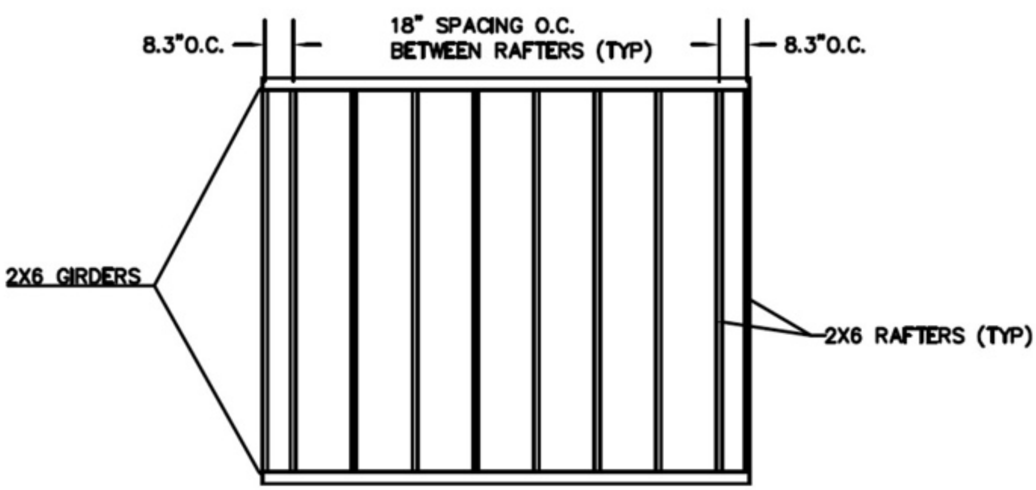

Figure 16. Framing Plan for Roof System.

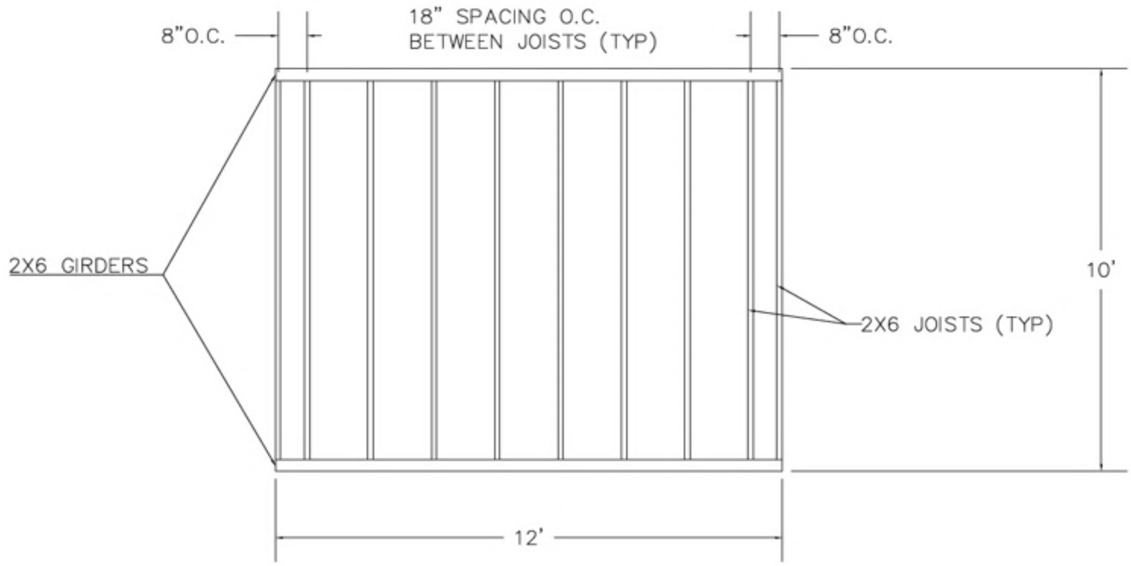

Figure 17. Framing Plan for Floor System.

3.5. Seismic and Lateral Force Design

The Garden Education Center will also be designed to resist loads due to seismic and lateral forces. The seismic forces on the structure will govern the lateral force design. For a one-story structure, the seismic base shear will be the force used to design the seismic resistance.

Shear Wall Design

As discussed in section 3.4.1, SFRS A15 was selected from ASCE 7-16 to resist seismic shear forces on the structure. The shear walls were laid out based on the conceptual design of the Garden Education Center. Each wall's dimensions were determined by the SDPWS 2021 height to base ratios for seismic shear resistance of wood structural panels. Figures 18 to 21 show the locations and dimensions of the shear walls on the structure.

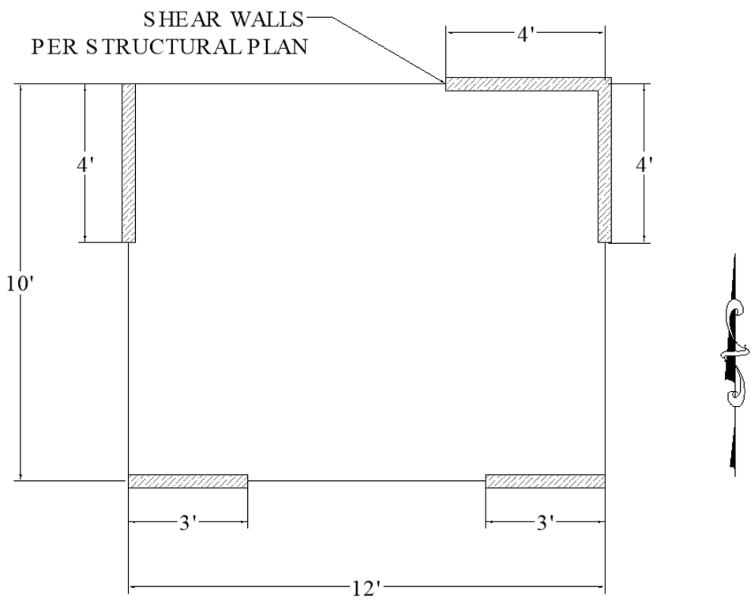

Figure 18. Plan View showing location of Shear Walls.

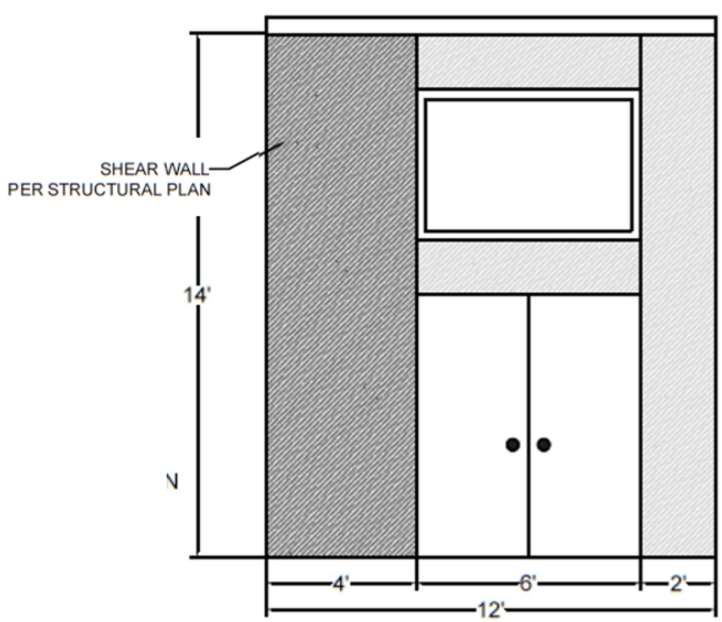

Figure 19. North Elevation View Shear Wall Plan

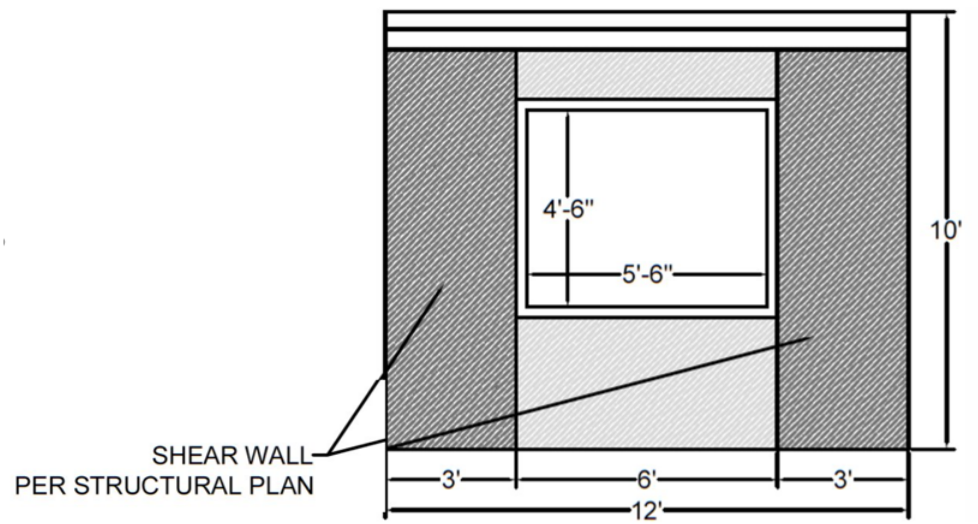

Figure 20. South Elevation View Shear Wall Plan

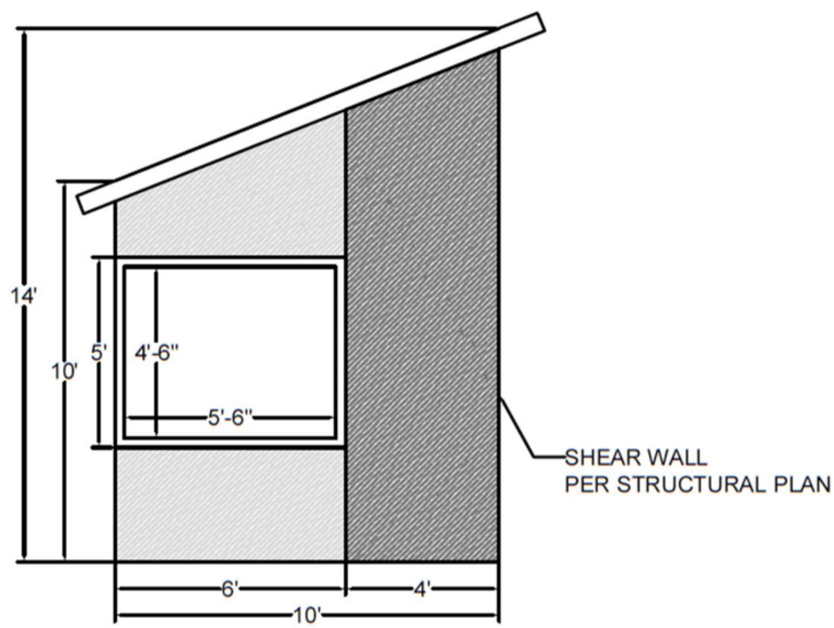

Figure 21. East/West Elevation View Shear Wall Plan

The shear strength required by the shear walls was determined by applying the seismic base shear in both the North-South and East-West directions. The seismic base shear was divided by the length of shear wall in the direction of interest to get the shear demand. Plywood structural sheathing panels at 3/8-inch thickness were determined to have an appropriate shear strength rating with a safety factor of 1.5. The shear wall material details and nailing pattern are shown in Table 11 .

Table 11. Shear Wall Materials and Nailing.

Shear Wall Material Specifications	
Material	Plywood Sheathing Structural Panel
Wood Specification	STRUCTURAL 1
Thickness (in)	0.375
Minimum Nail Bearing Length in Framing and Blocking (in)	1.375
Panel Nail Edge Spacing (in)	6
Vs (plf)	645
Ga (k/in)	14

The shear walls must also resist the overturning moment caused by the seismic base shear on the structure. The shear walls are a segmented system so each wall will have two seismic hold-downs. The overturning moment on each shear wall was resolved into a tension-compression couple at the hold-down locations. Figure 22 shows the hold-down locations for a segmented shear wall system. The hold-down type was selected to resist the maximum tension load on all shear walls. Then the hold-down type was checked to ensure that it could connect to the 2 by 6 studs, which act as the shear wall chords. Table 12 summarizes the selected hold-down and fastenings.

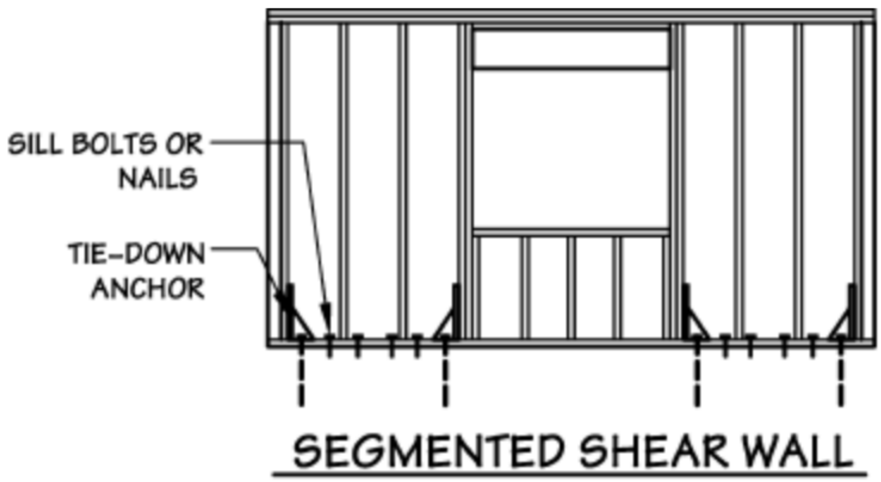

Figure 22. Seismic Hold-Down Locations (Breyer et. al., 2015).

Table 12. Hold-Down Selection and Fastenings.

Seismic Hold-Down Material Specifications	
Installation	Post Pour
Connection Materials	Wood to Concrete
SST Heavy Tension Tie	HTT4
Anchor Rod Diameter (in)	0.625
Wood Fasteners (in)	(18) #19 by 1.5" SD
Min Wood Member Size (in)	2 by 6
Allowable Tension Load (lb)	4455

Each shear wall was checked for acceptable deflection per NDS 2018. Based on these deflections, P-delta effects do not need to be considered for the design.

Diaphragm Design.

The structure's diaphragm must be designed to resist seismic shear forces received from the shear walls. Based on the seismic base shear and the shear wall design the diaphragm fasteners must be able to resist the loads summarized in Table 13.

Diaphragm fasteners and spacing were not designed yet for this structure. Please see section 3.9.6 for future recommendations on the diaphragm design.

Table 13. Shear Demand on Diaphragm Fasteners.

Diaphragm Fastener Shear Force	
Direction	Loads on Diaphragm from Shear walls (lb/ft)
N-S	123.7
E-W	154.6

Collector Design.

The structure must contain collector elements. The collectors were sized based on IBC 2018's guidance for header design and AWC's maximum span calculator. The collectors will be doubled 2 by 4 Douglas-fir larch placed over each door and window.

Table 14. Collector Material Specifications.

Collector Elements	
Material	No. 1 Douglas Fir Larch
Nominal Size	2 by 4
Deflection Limit	L/360
Maximum Horizontal Span (ft)	7
Quantity	2 per collector
Locations	Above all windows and doors

Perpendicular Wind Loads to Components and Cladding.

The wall cladding and roof cladding of the structure were checked for appropriate resistance to the maximum wind pressure on components and cladding. The wind pressures on each zone of the walls and roof were determined using the procedures outlined in ASCE 7-16 chapter 30. The maximum wind pressures from all zones of the walls and roof were selected and compared to the strength of the material resisting the pressure. Table 15 summarizes the strength capacity of the claddings and maximum wind pressures.

Table 15. Wall and Roof Cladding Perpendicular Strength and Wind Pressure Demands.

Wall Cladding		Roof Cladding	
Material	Plywood Panels	*Material*	Polycarbonate Panels
Thickness (in)	0.375	*Thickness (in)*	0.315
Nominal Uniform Load Capacity for 24 in Spacing (psf)	30	*Flexural Strength (psi)*	13500
Maximum Wall Cladding Wind Pressure (psf)	-22.08	*Maximum Roof Cladding Wind Pressure (psf)*	-36.48

3.6. Foundation Design

3.6.1. Soil Properties

Since the team does not possess a geotechnical report for the site, boring log reports were analyzed from a site 0.3 miles away from the Songs at LAEV site. These reports were obtained from the GeoTracker website, which contains records for sites that require cleanup. The reports show that the soil is likely a silty sand with an average blow count of 24, once applying a correction factor from Cal MOD SS to Standard Penetration Test. The moist unit weight and friction angle were estimated based upon the blow counts and the Hantaka & Uchida SPT friction angle correlation for sands. These properties are reflected in Appendix A. The boring log reports and California Department of Water Resources Groundwater Level reports also indicate that the phreatic surface is deep and will not interfere with upper soil layers.

3.6.2. Footing Design

The structure followed the IBC Section 1809.7 requirements for Prescriptive Footings Supporting Walls of Light-Frame Construction. The design utilized a continuous strip footing along the perimeter of the structure. The ultimate bearing capacity was checked using Terzaghi and Meyerhof approaches, with continuous strip and rectangular shape factors. Immediate settlement was considered using the Timoshenko and Goodier Theory of Elasticity. This settlement was less than 0.1% of the height of the sand layer, indicating minimal settlement. These calculations are reflected in Appendix A. The footing design is illustrated in Figure 23. The reinforcement in the strip footing is designed to be 2 #4 bars placed longitudinally and 2 #4 bars placed transversely. All reinforcement will have a 2-inch cover to meet minimum requirements.

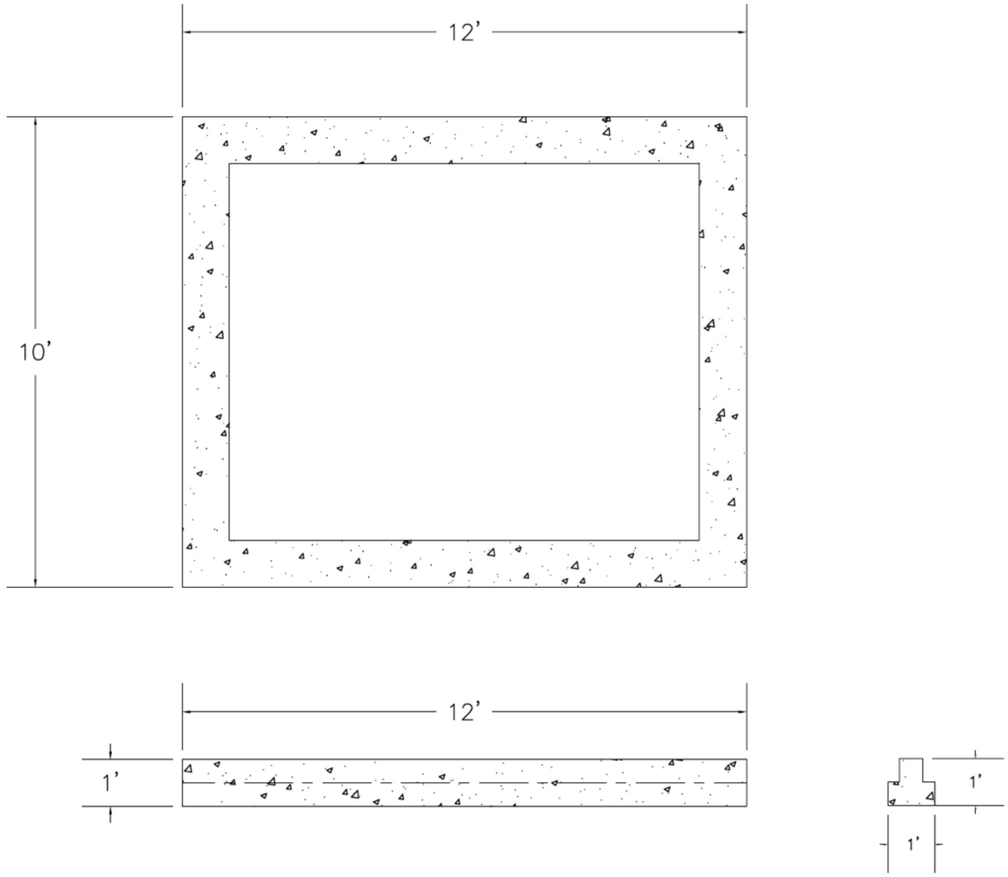

Figure 23. Garden Education Center Foundation Detail.

3.7. ADA Regulations

The garden structure will be designed in accordance with the California American with Disabilities Act (ADA). The door of the garden education center is designed in compliance with S3235 of the California ADA. The on-site door will be the side swinging type with a direct and obvious exit path. The door will be 7′ x 6′ in accordance with ADA minimum door dimension requirements. The proposed development will not include stairs or ramps to be considered for ADA compliance.

3.8. Design Alternatives

The initial design was a pitched roof greenhouse for the learning garden. Upon further consideration, a greenhouse was not necessary for LAEV since the community already grows seasonal fruits and vegetables, and the location did not fully satisfy the sunlight requirements of a greenhouse design. The structure now serves as a learning area to meet community needs more directly. It also incorporates a monoslope roof to better capture rainwater.

3.9. Future Recommendations

3.9.1. Garden Path

The Eco-Lions Engineering team proposes building a path through the garden using recycled bricks from the demolition of the former restaurant structure in the Northwest portion of the site.

3.9.2. Produce Washing Station

A produce washing station that utilizes collected water from the roof of the structure is recommended. Eco Lions Engineering has discussed the use of recycled tubs as produce washing stations with members of the LAEV community.

3.9.3. Solar Panels

The addition of solar panels to the roof of the Garden Education Center (GEC) would be beneficial for generating on-site, renewable energy. The roof of the GEC has already been sized to carry additional loads from the solar panels.

3.9.4. Signage

One of the main focuses of the learning garden is community education, and a potential option to achieve better education is signage. This addition is suggested to help visitors understand the process of urban gardening.

3.9.5. Methane Intrusion

Eco-Lions Engineering recommends that the LAEV carefully consider methane intrusion in the design of the concrete slab. According to the Department of Building and Safety ZIMAS website, the Song's at LAEV site is located in a Methane Hazard Zone. It is recommended that a vapor barrier is installed under the concrete slab to prevent methane from leaching through the soil and into the building.

3.9.6. Further Analysis of Diaphragm Design

This design does not include a thorough design of the structure's diaphragm. Eco-Lions Engineering recommends further analysis of polycarbonate paneling shear strength capacity from different manufacturers. Once a manufacturer is selected, the shear strength capacity can be used to determine an appropriate fastener arrangement for seismic force resistance.

Eco-Lions Engineering also recommends checking the diaphragm chords for appropriate strength based on the polycarbonate paneling fastener arrangement.

RAINWATER COLLECTION, STORAGE, AND USE

4.1. Conceptual Design

The existing former auto-shop structure and proposed garden education center are both to be equipped with collection tanks connected to the corresponding downspouts, as shown in Figures 24 and 25.

4.1.1. Process Flow Diagram

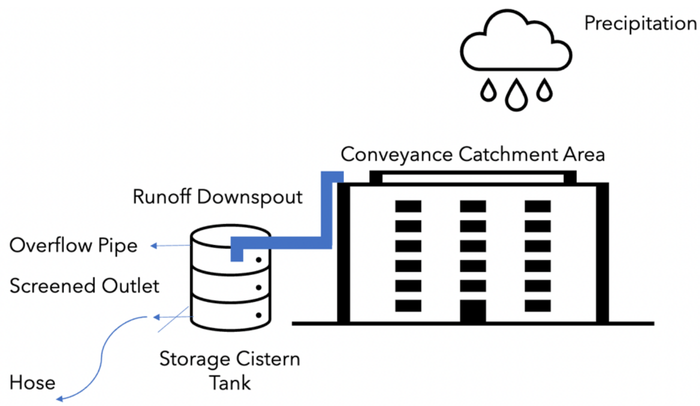

Figure 24. Process Flow Diagram of Rainwater Capture from Former Auto shop.

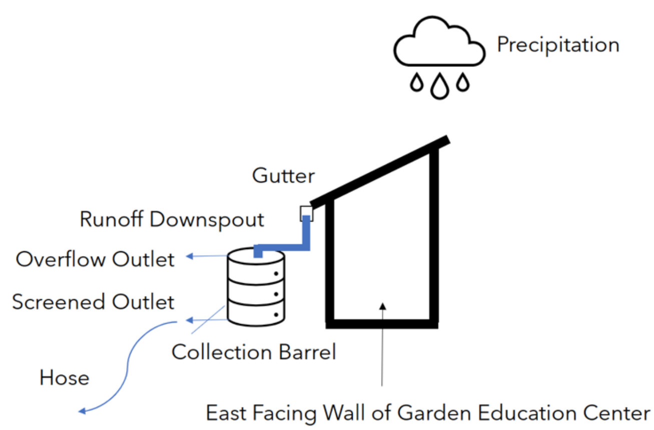

Figure 25. Process Flow Diagram of Rainwater Capture from Garden Education Center.

4.2. Low Impact Development

The Song's site at the LAEV is classified by the Los Angeles Country Department of Public Works as a Designated Redevelopment Project. Specifically, it is a redevelopment that results in replacement of 5,000 square feet or more of impervious surface of a site that was previously developed as an automotive service facility with 5,000 square feet or more of surface area. By the time of the implementation of the design elements included in this report, all impervious asphalt and concrete ground surfaces will have been removed and left as remediated soil. Therefore, the project falls under the conditions of a site where less than 50 percent of the impervious surface is proposed to be altered, "only the proposed alteration must meet the requirements of the LID Standards Manual." (County of Los Angeles, 2014).

The stormwater management requirements for the given project therefore is to retain 100 percent of the stormwater quality design volume on site from the proposed development alterations using infiltration, evapotranspiration, runoff harvest and use, or a combination of these methods. Designated projects must: conduct site assessment to identify feasibility and design considerations, apply site specific source control measures, calculate the stormwater quality design volume, implement stormwater quality control measures, and implement any further compliances or requirements if deemed necessary.

The proposed BMP for the Song's at LAEV site is a collection and use system for the roof areas of the existing auto shop and proposed garden structure. It is the desire of the LAEV community to maximize the potential of harvesting rainwater than explore infiltration BMPs. There are a number of applicable non-potable uses for the site including irrigation use for the future diversity garden and proposed learning garden, the proposed vegetable washing station, and the aquaponics system.

4.3. Site Hydrology Assessment

4.3.1. Rainfall Frequencies

It is required by the LA City LID requirements to design for the 85th percentile, 24-hour rain event. The team must consider incremental periods with high intensity rainfall. The rainfall hydrograph has a peak intensity about ¾ of the way through the 24-hour storm, as seen in Figure 26 below. This is developed through a computer program, which generates volume and peak rate. It specifies the 85th percentile rainfall value to be approximately 1 inch. The corresponding rainfall intensity for this value is approximately 0.04 inches per hour over a 24-hour period.

4.3.2. Hydrology Calculations

Runoff coefficients for impervious surfaces of the site were determined using Table 3-2 from the NCDENR Stormwater BMP Manual. the roof of the auto shop, a runoff coefficient of 0.9 was used for a flat roof. For the inclined roof of the garden structure, the runoff coefficient is 1.0. The soil type for the unpaved portion of the site was found according to the LA county hydrology map and determined to be soil type 004. According to the LACDPW Runoff Coefficient Curve, this soil type under the intensity determined above yields an undeveloped runoff coefficient of 0.1.

The total site runoff was calculated for the Songs site using the Modified Rational Method through the LA County HydroCalc Software. The peak flow for the site is approximately 0.0176 cubic feet per second as shown in the runoff hydrograph in Figure 26. The total rainwater collection volume applied only to runoff from the roof areas of the existing auto shop building roof and proposed garden structure roof. The total site runoff and total collection volume are shown in Table 16.

Table 16. Site Runoff and Flow Rate Volumes

	Cubic Feet	Gallons
Total Site Runoff	237.1	1744.6
Rainwater Collection Volume	163.8	1225.0

	Cubic Feet per Second (cfs)	Gallons Per Minute (gpm)
Peak Flow Rate	0.0176	7.90

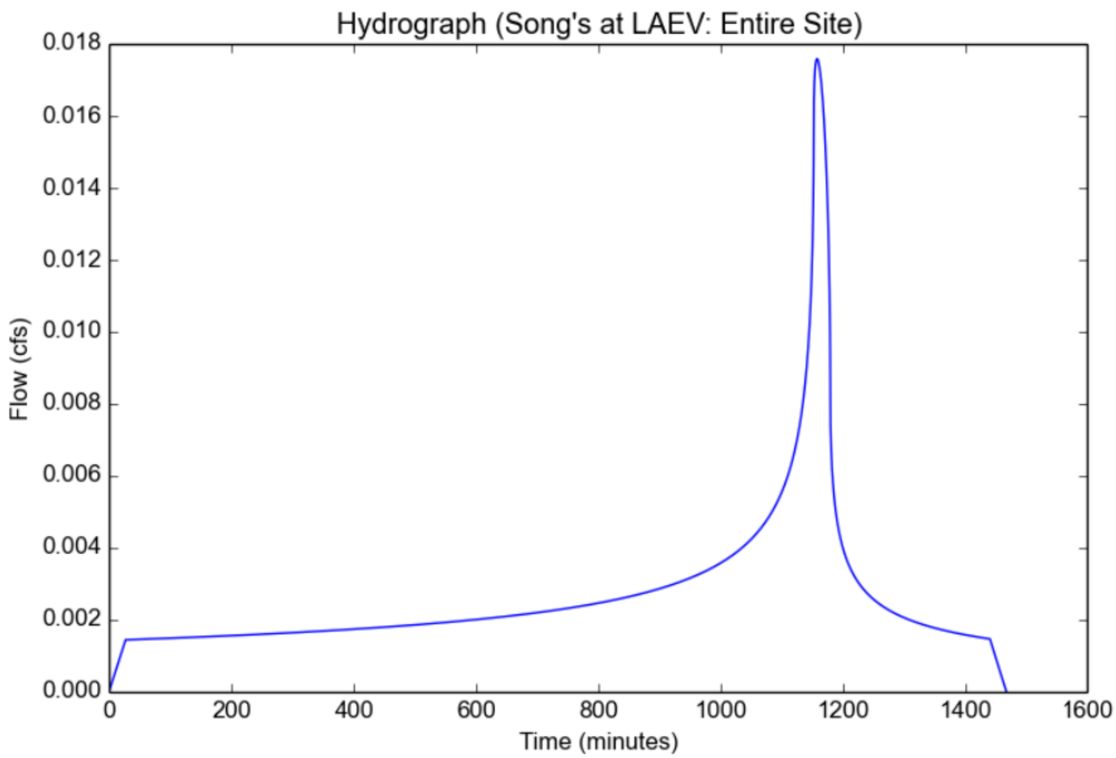

Figure 26. Hydrograph for the Song's Site

4.3.3. Capture and Use Feasibility

Per the Los Angeles City LID Manual, a site's feasibility for a capture and use BMP is determined by the Estimated Total Water Use for irrigation from October 1st to April 30th. This volume must be greater than or equal to the volume of water produced by the stormwater design storm event. The rainwater collection volume for the scope of this project is approximately 1,160 gallons. Estimated Total Water Use for the site was determined using sample calculations from the Los Angeles County Department of Public Works Low Impact Development Standards Manual. A standard planting factor of 0.3 and average 7-month evapotranspiration value of

21.7 inches were used for the site. The estimated total water use for 7-month wet period was determined to be approximately 35,673 gallons per the calculations in Appendix B. For capture and use to be feasible, this value must be greater than or equal to the design collection volume.

$$ETWU_{7\ month} \geq V_{design}$$

Therefore, capture and use is a feasible BMP option. The site must also apply and receive approval from the County of Los Angeles, Department of Public Health for a capture and use system.

4.4. Non-Potable Water Uses

The Song's at LAEV site has a high non-potable water demand, which is why rainwater harvesting is the best stormwater management option for the community. On-site irrigation for the current learning garden, future learning garden, or even on the LAEV property itself are just a few potential uses for the collected runoff. Other on-site uses include replenishing the new aquaponics system or the vegetable washing station being considered as an addition to the learning garden.

4.5. Tank Sizing and Connections

4.5.1. Cisterns and Rain Barrels

One large 1200-gallon cistern will be installed on the west side of the auto shop structure and connect to the existing downspout for rainwater collection. One 75-gallon plastic storage tank will connect to the downspout of the garden structure. The corresponding tank dimensions, provided from ProTank.com are shown in Table 17.

Table 17. Tank Dimensions

	Rainwater Collection Volume (gallons)	Tank Size (gallons)
Songs Building Roof	1192.6	1200
GEC Roof	72.8	75

Tank Size (gallons)	Diameter (in)	Height (in)
1200	76	66
75	23	50

4.5.2. Connection Details

The 1200-gallon cistern will connect to the 4" diameter downspout proposed per the separate structural retrofit plan for the auto shop structure. The downspout connection detail is shown in Figure 27. The 75-gallon rain barrel will connect to the 3" diameter downspout proposed for the garden education center structure. The downspout connection detail is shown in Figure 28.

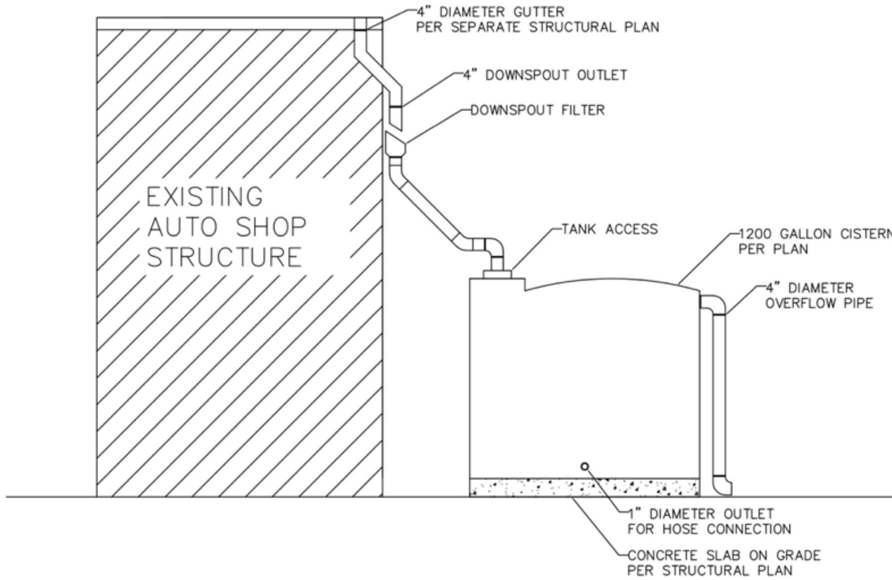

Figure 27. 1200-gallon cistern downspout connection detail.

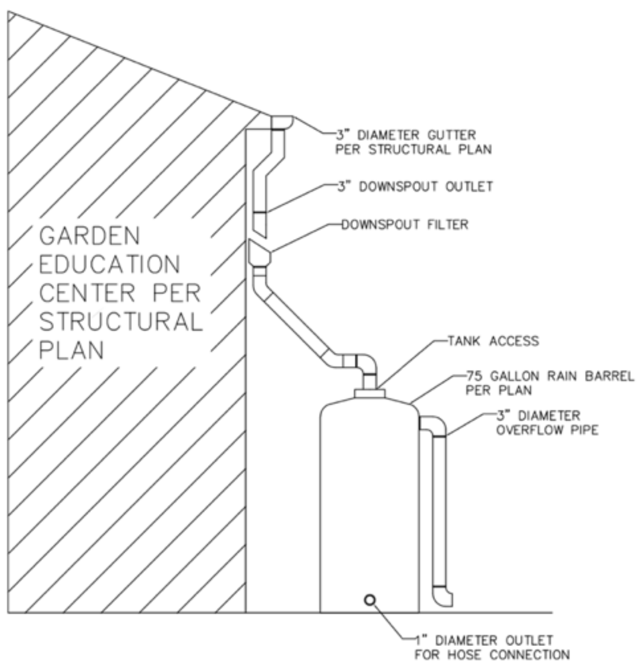

Figure 28. 75-gallon rain barrel connection detail.

4.6. Structural Design

4.6.1. Seismic Bracing for Cisterns

Both the 1200-gallon cistern and 75-gallon rain barrel will be anchored to a concrete foundation through a steel plate. The anchorage has been designed to resist seismic forces for a non-structural component based on ASCE 7-16 chapter 13. This chapter is typically used for small water carrying tanks like those being used on this site. To account for the maximum possible force on the tank in the anchorage design, the seismic force (F_p) was calculated assuming each tank was full. Table 18 shows the seismic forces, overturning moment, and tension force due to the overturning moment.

Table 18. Seismic Forces for Tanks

Seismic Force on 1200-Gallon Cistern	
Fp Governing (lb)	13238
Fv (lb)	3309.5
Height to Center of Gravity (ft)	2.75
Overturning Moment (lb-ft)	36404
Distance Between T-C Anchors (ft)	4.48
Tension (lb)	8128.9

Seismic Force on 75-Gallon Rain Barrel	
Fp Governing (lb)	848.64
Fv (lb)	212.16
Height to Center of Gravity (ft)	2.08
Overturning Moment (lb-ft)	1768
Distance Between T-C Anchors (ft)	2.5
Tension (lb)	707.2

The overturning moment and tension force represent the seismic demand on the anchorage. The anchorage arrangement was optimized for the seismic demand using Hilti Profis Software. HIT-HY 200 V3 + HIT-Z ½" diameter anchors on a ½" thick steel plate were selected to anchor both tanks. Both tanks are anchored to 6-inch-thick concrete slab which was sized so that the anchors are located sufficiently far from the edge of the slab. Figures 29 and 30 below show the final anchorage arrangements and slab dimensions for each tank.

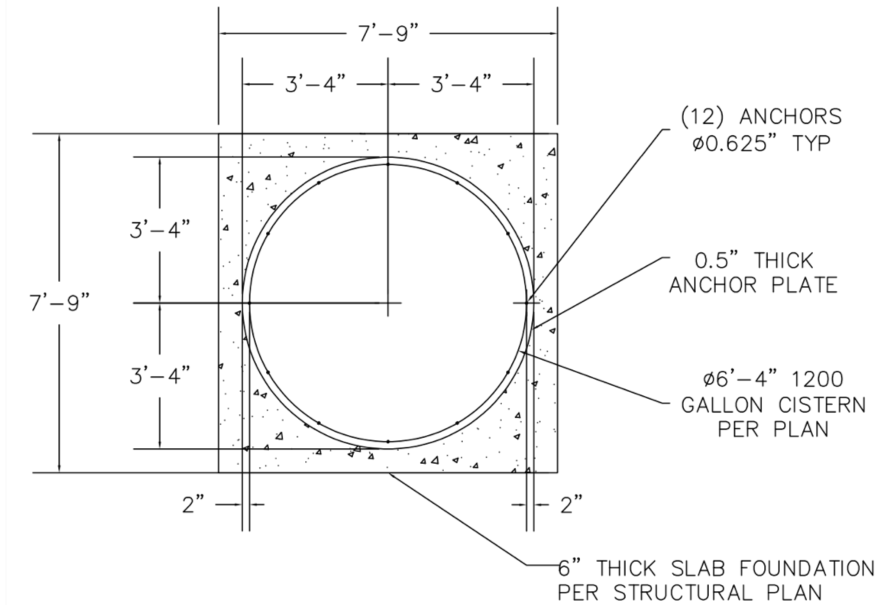

Figure 29. Seismic Bracing Detail for the 1200-gallon cistern.

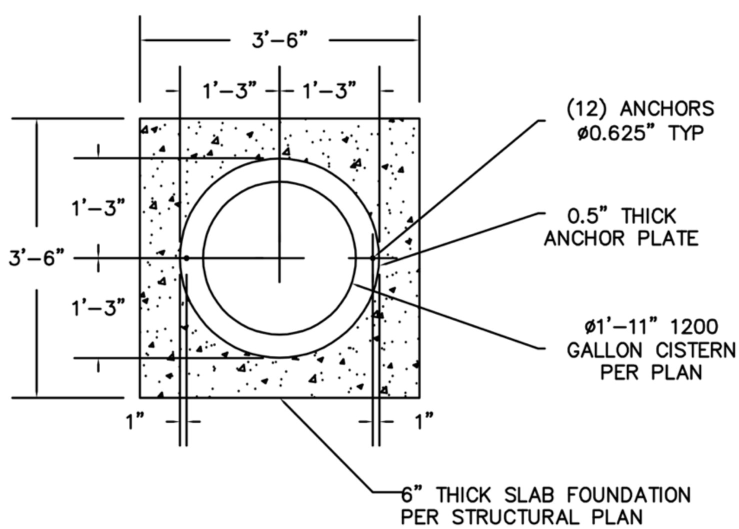

Figure 30. Seismic Bracing Detail for the 75-gallon rain barrel.

4.6.2. Tank Foundations

As described above in the seismic bracing section, each tank will be anchored to a 6-inch-thick concrete slab sized for appropriate anchor spacing. IBC 2018 does not list any foundation requirements for non-building structures, so the 6-inch slab is an adequate foundation. The same soil properties identified for the design of the Garden Education Center foundation were used to design these slabs. Each slab was checked for bearing capacity using both Terzaghi and Meyerhof approaches and determined to have satisfactory safety factors. Immediate settlement was considered for both slabs using the Timoshenko and Goodier Theory of Elasticity. This settlement was less than 0.1% of the height of the sand layer that the foundations rest on, indicating minimal settlement.

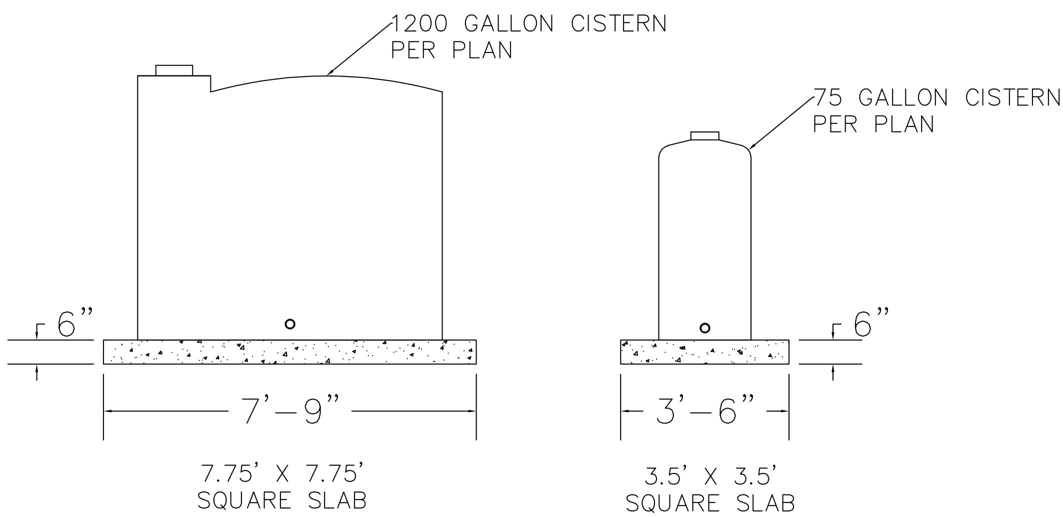

Figure 31. Tank Foundation Dimensions.

4.7. Design Alternatives

Eco-lions engineering is working under the assumption that soil remediation will be completed upon project implementation, therefore porous pavement and bioswales for additional rainwater collection for the pervious soil areas were considered. Upon discussion with LAEV community members this was not the most economical or desirable option and has been adapted to a future recommendation. Underground storage was initially considered to collect rainwater for the site. However above ground storage was ultimately selected for roof runoff capture to inspire at-home rainwater harvesting systems for visitors.

4.8. Future Recommendations

4.8.1. Design Volume based on Climate Projections

The recommended tank size is based upon LA County guidelines, but LAEV community members suggested the opportunity to hold as much rainfall as possible, beyond the 85^{th} percentile, 24-hour rain event. The Eco Lions team developed a program to estimate the rainfall volume and peak rate for any area in Los Angeles, based upon historical data and future climate projections. The program utilizes 15-minute rainfall intensity data for any specified polygon area on an interactive map, to determine the most accurate collection and use volume. This will ensure that the sized storage tanks will hold as much water as needed for the current, site weather conditions. Climate projections will also forecast whether the cistern size will be viable in years to come.

4.8.2. Site Runoff Collection and Infiltration

Eco-Lions engineering only proposed a design to collect runoff from the rooftops of the Songs Site. In order for the LAEV community to reach its goal of collecting 100% of runoff from the restored site, there are several ways to collect water from the ground runoff as well. This can be achieved through the construction of detention basins or retention ponds, which can temporarily store water for irrigation or other non-potable uses. The community may also want to consider the eventual addition of an underground storage tank or cistern. This method would not require the loss of any site space like a detention basin or pond would and could allow for a larger capacity and duration of storing site runoff for non-potable uses.

4.8.3. Rebates and Incentives

There are several rebates and incentive programs in effect that would apply to the Songs at LAEV site. These rebated could be utilized to ease the cost of implementing the proposed rainwater harvesting system. SoCal Water$mart is a private organization that offers residential rebates for collection cisterns. A qualifying cistern with a capacity of 1000 or more gallons can receive a rebate of $350. The program requires that the cistern connect to an existing downspout and gutter system, is elevated under a solid foundation, must be purchased as an entire unit, have an overflow spigot, and be properly mounted to receive all water from the downspout. Rainplan, another private organization, offers a Green Spending Advance to qualifying sites with eligible projects including harvest and use systems. This loan program is designed to assist private retrofit projects to implement green property improvements while easing the out-of-pocket expenses prior to completion of the project. This payment plan may help the LA Ecovillage to implement the proposed system sooner.

AQUAPONICS

5.1. Design Layout

The aquaponics system is located along the south wall of the auto shop structure as shown in Figure 32.

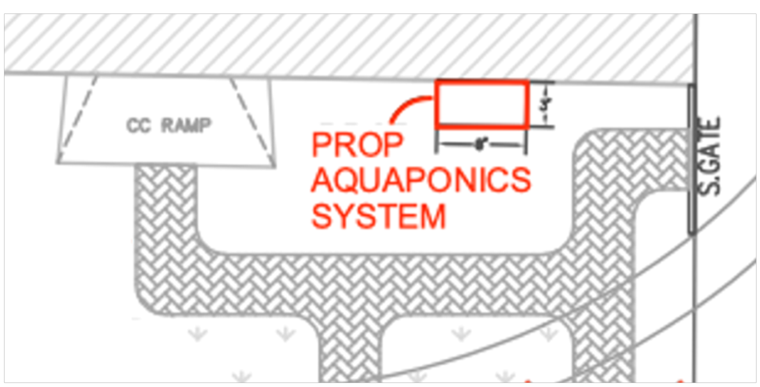

Figure 32. Clip of Aquaponics System Location on Site Plan.

5.2. Process Block Diagram

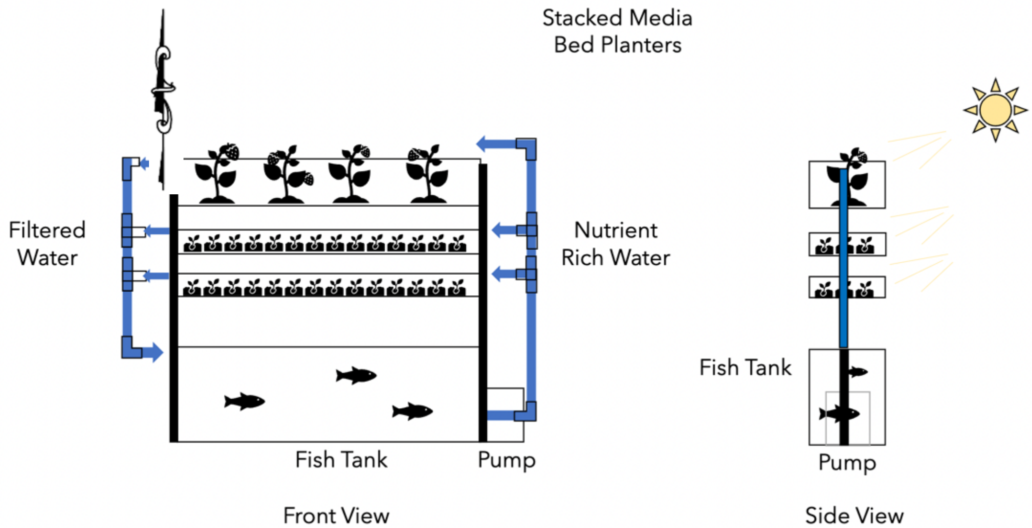

Figure 33. Process Diagram of Aquaponics System.

5.3. Fish and Plant Integration

The fish to be integrated to the new aquaponics system are Blue Tilapia. The system is based upon the recommended starting number of 20 fish. Tilapia is the most common choice of fish in an aquaponics system because they are very low maintenance and effective. As a freshwater species, tilapia can tolerate crowding, temperature variation, and high levels of potassium, which is an important element to supplemental plant growth (Aquaculture Production Systems, 349). This species of tilapia can attain 0.75 lb by the end of the growing season and achieve an adult weight of 3-4lbs. Alternative freshwater species also commonly used in aquaponics systems include:

- Murray Cod
- Asian Sea Bass
- Common and Koi Carp
- Pacu Fish
- Crappies
- Rainbow Trout
- Largemouth Bass

There is a variety of plant life that can be grown in an aquaponics system that is sustainable and useful for the LAEV community. Plants that are best suited to an aquaponics system are those considered “nutrient hungry,” meaning they grow very well in the nutrient rich environment that the aquaponics system creates. The three most common aquaponics crops are basil, tomatoes, and salad greens (David C. Love et. al). Some other plants that do exceptionally well in an aquaponics system include:

- Herbs
- Peppers
- Lettuce and cabbage
- Cucumbers
- Kale
- Strawberries

- Beans and peas
- Broccoli
- Cauliflower

It is noted the LAEV community primarily grows lettuce in the existing aquaponics system on site. The new aquaponics design will be able to grow a larger amount and wider variety of plant life among any of the crops listed above due to the new vertical design. This expanded production will help serve community members by providing fruits and vegetables year-round. Another recent aquaponics phenomenon of great interest to the LAEV community are microgreens. They are quick to harvest, high in nutrients, easy to grow, and in high demand. The most common, profitable microgreens include (Go Green Aquaponics, n.d.):

- Arugula
- Pea Shoots
- Mustard
- Radish
- Kale
- Coriander
- Basil

In addition to easy growth and harvest, they are a high-value crop. Many growers can produce upwards of 50lbs in a two-week cycle for a 60sf space. If this is priced at

$20 per pound, this can produce about $2,000 per month (GroCycle, n.d.). LAEV community members were fond of the idea of microgreens, and they have been integrated into the system design.

5.4. System Selection and Media

There are three types of aquaponics growing techniques: media beds, nutrient film technique (NFT), or raft/deep water culture (DWC). The current LAEV aquaponics system is a media bed filter, which is most common for small scale systems. Eco-lions Engineering has determined the new design should also be of this type, as the maintenance is already familiar to the community and this technique is the most suitable for new aquaponics. Media grow beds allow for sufficient nitrification to reduce the risks of ammonia peaks caused by overfeeding and overstocking of fish. It easily meets the needs of nitrifying and mineralization necessary for plants to thrive, and self-filters solid west from the fish tank. The type of media best suited for the aquaponics system has been decided based on size, weight, shape, pH neutrality, porosity, and cost. Lava rock is the most optimal option as it has an angular shape, neutral pH, and high porosity. It also does not float. LAEV is also currently using it for their prototype system. Based upon the soil properties and existing supply, this makes lava rock the cheapest and most efficient media (Go Green Aquaponics, n.d.).

5.5. System Water and Aeration Design

It is important to consider the Dissolved Oxygen (DO) in aquaponics to maintain respiration for fish, nutrients for plants, and bacteria for converting fish waste into these plant-supporting nutrients. The amount of DO required in the system is dependent upon fish type, water temperature, and tank size. Generally, warm water fish require about 5mg/L of DO to maintain good health but some fish, like the Blue Tilapia used in our system, can thrive off lower levels. In general, plants require a DO of about 4-12mg/L for respiration. DO is maintained by the process of aeration, which creates water movement. Air pumps and air stones are the most common and reliable aeration process for aquaponics systems. They can provide the exact amount of oxygen needed per pump size and remain functioning even if the pump fails. Air stones are also one of the most economical options. The smaller the pores in the stones, the more oxygen will be delivered (Go Green Aquaponics, n.d.). For a 240-gallon fish tank, 6" medium pore diffusers provide adequate DO, without the need to purchase too many stones. There are three steps in sizing an aerator:

1. Calculate the amount of oxygen needed for the system based upon the daily feed rate.
2. Determine the number of diffusers/air stones to supply the amount of oxygen needed.

3. Quantify the minimum CFM produced by an air pump that will supply the oxygen diffusion rate at the depth of the fish tank.

The oxygen injection formula is as follows:

$$\text{Injection rate}\left(\frac{O_2}{\text{hr}}\right)$$
$$= \text{diffuser(cfm)} \cdot \text{wt air}\left(\frac{\text{lb}}{\text{ft}^3}\right) \cdot \frac{O_2}{\text{air}}\left(\frac{\text{lb}}{\text{lb}}\right) \cdot \text{SOTE}\left(\frac{\text{lb}}{\text{depth(ft)}}\right) \cdot \text{d(ft)} \cdot \text{FTE} \cdot \text{T}\left(\frac{\text{min}}{\text{(hr)}}\right)$$

This calculation utilized a 0.5:1 oxygen to feed ratio, and 0.01 SOTE, Standard Oxygen Transfer Efficiency rate for the pore size. This was based upon standard conditions per 1ft of depth. 6” medium pore diffusers supply approximately 0.5cfm. This resulted in an oxygen injection of 0.005lbs of O2/hr.

The number of air stones was determined by dividing the weight of feed per hour by the weight of O2 per hour. Therefore, the minimum required volumetric flow at the fish tank depth is as follows (Urban Space Aquaponics, n.d.):

$$\text{Pump Size}\left(\frac{\text{L}}{\text{hr}}\right) = \text{number of stones} \cdot \text{diffuser (cfm)}$$

This value was multiplied by a safety factor of 1.5 and adjusted to the elevation of LA Eco Village above sea level.

Table 19. Aeration Design Specifications.

Aerator Size	Air Stone Size	Number of Air Stones
9000 L/H	6" medium pore diffusers	7

The calculations are reflected in Appendix D. Additional requirements include a regulated temperature between 54- and 90-degrees Fahrenheit in order to prevent fish disease and death. This can be achieved with a water heater and proper tank insulation.

5.6. Operations and Maintenance

Aquaponics systems require regular maintenance to ensure the system is running properly and to avoid disease and death in the fish tank. The operation requirements for the proposed system can be seen in Table 20.

Table 20. Aquaponics System Maintenance Requirements.

Water Requirements	- Temperature between 54- and 90-degrees Fahrenheit. - Dissolved Oxygen volume of 4-12 milligrams per liter of water.
Fertilizer Requirements	- pH level between 4 and 9. - Primary chemicals (nitrogen and phosphorous) must be checked every 2 to 4 weeks. - Secondary chemicals (potassium, calcium, sulfur, magnesium) must be checked every 2 to 4 weeks. - Minimum 0.5:1 feed to fish ratio.
Filtration Requirements	- Fish tank volume must be cycled completely through the media bed volume 1-2 times per hour

5.7. Hydraulics Design

The fish tank volume is designed match the grow bed volume with a 1:1 tank to bed ratio, and a 3:1 tank to fish ratio. Since tilapia can grow between 3-4lbs, they require about 12 gallons per fish (Aquaponics Advisor, n.d.). The microgreen media beds only require a depth of 1-4", therefore the two microgreen media meds were sized for a depth of 4” with an additional ½" of space to ensure opportunity to grow various species. The fruit/vegetable media bed is sized for 12”, to also ensure opportunity to grow various species. This media bed is placed at the top of the system to avoid prohibiting plant height. Since microgreens only require 4 hours of sunlight and the structure is placed against the south facing wall of the existing auto shop wall, which receives direct sunlight, microgreen growth is not affected by the vertical stack design. Additionally, during early microgreen germination stages the plant grows best in a shaded or covered environment (Go Green Aquaponics n.d.). Therefore, this design provides more optimal sunlight for the fruit/vegetable bed, and more shading for the microgreens, supporting better growth.

The aquaponics pump was sized with three main considerations:

1. Distance the water is lifted against gravity.
2. Volume of water to fill the grow beds in the amount of time the pump is running.
3. Fish tank turnover.

A general aquaponics rule of thumb is to cycle the fish tank volume through the media bed volume at least 1-2 times/hour (HowToAquaponics, n.d.). Therefore, the pump was sized based on the fish tank volume and a 15-minute timer system to turn on 4 times per hour, 5 minutes on and 10 minutes off. For optimal circulation of once per hour through the three media beds, the required volume flow rate is reflected in the tables below. To save energy, the pump can be sized for a circulation of once per hour, but because of the stacked design and head loss, based upon the pump curve the pump size would remain relatively close to the most optimal circulation flow rate. These alternatives are reflected in Appendix D.

PVC is the design material selected for piping. This is the cheapest alternative, and easiest to manipulate for system construction. Based upon an average pressure of about 20-100psi and 6-12ft/s flow velocity, the pipe size for this system should be between ½-¾”. For a ¾" pipe, tilapia fingerlings may pass through the system, but this can be prevented by adding a screen. This will also be dependent on the fish source. These sizes are based on rigid PVC piping, and will require approximately 4 tee fittings, and 5 elbow fittings with a 0.85-1.06” diameter (FlexPVC, n.d.).

Table 21. Hydraulic Design Specifications

	Volume (gallons)	Area (ft^2)
Fish Tank	270 (holds 240)	18
Microgreens Media Beds (x2)	51	18
Fruit/Vegetable Media Beds (x1)	135	18
Tank Type	**Depth/Bed Height (ft)**	**Total Headloss (ft)**
Fish Tank	2	0
Microgreens Media Bed 1	0.375	2.375
Microgreens Media Bed 2	0.357	3.75
Fruit/Vegetable Media Bed	1	5.75
Pump Size	**Pipe Size**	
800-1000 GPH	½-¾"	

5.8. Structural Design

5.8.1. Framing Design

The vertical aquaponics system will be supported by a wood frame structure. The frame will use No. 1 Douglas Firs Larch members, consistent with the members of Garden Education Center. Douglas Fir was selected for the benefits described in the Structural Materials section of the Learning Garden, as well as for the potential cost savings when purchasing bulk members of the same size. The conceptual framing design was to have the fish tank carried by simply supported beams and each media bed above carried by cantilever beams. Simply supported beams were selected to carry the fish tank due to its heavy weight. Cantilevers were selected to carry the media beds to increase accessibility for harvesting. The process used to determine the member sizes for the frame is as follows:

1. Compute the maximum loads from each of the media beds and fish tank. These will be considered the dead loads on each "story" of the aquaponics system.
2. Compute 1.4 times the dead load on each story, the first LRFD load combination. This will be used as the design load. Since the aquaponics system is not a building it does not have the other loads necessary to compute all LRFD combinations.
3. Determine a preliminary framing design using conservative member sizes.
4. Check the member capacities such as shear, bending, axial compression and deflection per AWC NDS regulations.
5. Compare the member capacities to the member demand.
6. Resize the member to optimize if the capacities are greater than the demand.

The beams carrying the media beds and fish tanks will be sheathed with Structural 1 Plywood panels. This material was selected to match the shear walls used in the Garden Education Center. By choosing the same material, the costs for the sheathing were reduced. The wood members will be waterproofed with epoxy. The summary of the final structural members and sheathing can be viewed in Table 22 below. The framing plan for the system can be viewed in Figure 34 below.

Table 22. Structural Framing and Sheathing for Aquaponics System.

Structural Frame Material Details				
Member Name	*Quantity*	*Nominal Dimensions Selected (ft)*	*Length (ft)*	*Material*
Tall Columns	4	4 by 4	8	No. 1 Douglas Fir Larch
Short Columns	4	4 by 4	0.5	No. 1 Douglas Fir Larch
Beams	16	2 by 6	3	No. 1 Douglas Fir Larch
Girders	5	2 by 10	6	No. 1 Douglas Fir Larch

Structural Sheathing Material Details				
Material	*Area (sq ft)*	*Thickness (in)*	*Minimum Nail Bearing Length in Framing and Blocking (in)*	*Panel Nail Edge Spacing (in)*
Plywood Sheathing Structural Panel	72	3/8	1.375	6

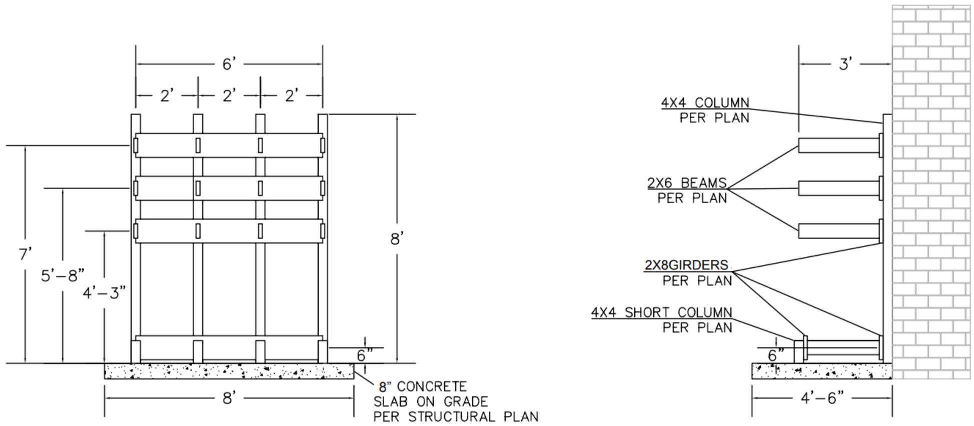

Figure 34. Aquaponics System Structural Framing Details.

5.8.2. Gravity and Seismic Bracing

The frame of the aquaponics system will be braced to resist the loads due to gravity. The aquaponics system is located along the CMU wall of the former auto-shop building. Each beam carrying a media bed will be braced to the CMU wall to resist the maximum overturning moment. The bracing details are shown in Table 23.

Table 23. Beam Bracing Specifications.

Bracing to CMU Wall Material Detail	
Maximum Moment on Beam (lb*in)	9517.952
Anchor Type	HY 270 + threaded rod 5.8
Anchor Diameter (in)	3/8
Embedment Depth (in)	4
No. of Anchors per Plate	4
Steel Plate Size (in)	12 by 12
Steel Plate Thickness (in)	0.4

The frame of the aquaponics system will also be braced to resist the loads due to lateral seismic forces. The anchorage has been designed to resist seismic forces for a non-structural component based on ASCE 7-16 chapter 13. In this case the aquaponics system is a non-structural component of the former auto-shop building. To account for the maximum possible force on the system in the anchorage design, the seismic force (F_p) was calculated assuming media bed was full, and the vegetables were fully grown. Table 24 shows the seismic forces, overturning moment, and tension force due to the overturning moment.

Table 24. Aquaponics Seismic Forces.

Seismic Forces on Aquaponics System	
Governing Fp (lb)	1078
Fv (lb)	718.5
Height to Center of Mass (ft)	6
*Overturning Moment (lb*in)*	77594
Tension (lb)	1078
Tension Demand for Anchors Carrying Load in Both Directions (lb)	2155

The tension demand for anchors that carry seismic forces in both lateral directions was used as the demand on the anchorage. The anchorage arrangement was optimized for the seismic demand using Hilti Profis Software.

Each of the four edge columns will be anchored to an 8-inch-thick concrete slab using a steel ledger plate. The anchor specifications can be seen in Table 25. The concrete slab will be large enough so that the full capacity of the anchors can be utilized.

Table 25. Aquaponics Seismic Anchor Specifications

Seismic Anchors on Columns to Concrete Slab	
Anchor Type	HIT-HY 200 V3 + HAS-V-36 (ASTM F1554 Gr.36)
Anchor Diameter (in)	1/2
Embedment Depth (in)	6.33
No. of Anchors Per Plate	2
Steel Ledger Plate Length (in)	12
Steel Plate Thickness (in)	1/2

5.8.3. Foundation Design

As described above in the seismic bracing section, the aquaponics system frame will be anchored to an 8-inch-thick concrete slab sized for appropriate anchor spacing. IBC 2018 does not list any foundation requirements for non-building structures, so the 8-inch slab is an adequate foundation. The same soil properties identified for the design of the Garden Education Center foundation were used to design these slabs. Each slab was checked for bearing capacity using the Meyerhof approach and determined to have satisfactory safety factors. Immediate settlement was considered for both slabs using the Timoshenko and Goodier Theory of Elasticity. This settlement was less than 0.1% of the height of the sand layer that the foundations rest on, indicating minimal settlement.

5.9. Design Alternatives

The nutrient film technique (NFT) and deep-water culture (DWC) aquaponics system techniques were considered as options for the design of a larger scale aquaponics system. Though more efficient for larger systems, the media bed technique offers a larger variety of growable produce options desired by the LAEV and is still very efficient for the proposed size. It is also the technique currently used and most familiar to the LAEV community members and is the easiest and most low-maintenance technique for beginners, making media bed aquaponics the best technique to educate visitors on at-home aquaponics systems. A peristaltic pump was also considered for the system. It is positive displacement and requires less energy to start and stop with continuous operation, however a timer system is more optimal for plant/fish health and growth. Finally, simply supported beams were considered to support the media beds which would allow for smaller beam sizing, but this option would decrease the ease of harvesting and produce a less aesthetically pleasing design.

5.10. Future Recommendations

LAEV community members were curious to see how interactive the newly designed aquaponics system could be. Since the community aims towards maximum energy efficiency and wishes to inspire visitors to build their own aquaponics systems, the Eco Lions team wanted to develop a design that is as hands-on as possible. As a substitute for an air pump and air stones, LAEV community members can also implement a manual paddlewheel for guests. The mechanical paddle-wheel design is generally used for larger ponds or systems but could also be implemented in a system of this size. Because of the lack of a timer and known flow rate, the DO must be checked regularly. But if LAEV utilized a DO meter or the colorimetric approach with a color meter, this could be viable and energy efficient option. Another, less hands-on, but energy efficient alternative would be to design the system so that the water exiting the media beds drops down into the fish tank in a manner that disturbs the surface and induces oxygen production.

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APPENDIX A: Structural Calculations

APPENDIX A-1

GARDEN EDUCATION CENTER STRUCTURAL CALCULATIONS

GARDEN EDUCATION CENTER - DEAD, LIVE, RAIN, & SNOW LOADS

Building Information	
Building Occupancy Risk Category (Table 1.5-1 ASCE 7-16)	1
Ie by Risk Category (Table 1.5-2 ASCE 7-16)	1
Ii by Risk Category (Table 1.5-2 ASCE 7-16)	0.8
Is by Risk Category (Table 1.5-2 ASCE 7-16)	0.8
Iw by Risk Category (Table 1.5-2 ASCE 7-16)	1

Roof Dead Load			
Material Type	Material, Qty.	Weight (psf)	
Roof Paneling	polycarbonate	1.93	**based on wt. of 8mm(0.315")panel*
Girders	2x12, 2	1.5	**assumed*
Rafters	2x6, 9	6.0	**assumed*
Utilities/Lights	N/A	2.0	**assumed*
Solar Panels	N/A	2.0	**assuming 50 lb solar panel*
Total	-	**13.43**	
Rounded Total	-	**13.5**	

Roof Live Load	
L0 (psf) (ASCE 7-16 Table 4.3-1)	20.0
Live Load Reduction (ASCE 7-16 Table 4.3-1)	Yes
At (sq ft)	16.2
Total Rise of Roof (in)	48.0
Roof Span in Direction of Slope (ft)	10.0
F	4.8
R1 (Equation 4.8-1 ASCE 7-16)	1.0
R2 (Equation 4.8-1 ASCE 7-16)	1.0
Lr (psf) (Equation 4.8-1 ASCE 7-16)	19.2

Snow Load		
Ground Snow Load (psf)	0.00	**https://hazards.atcouncil.org*
Flat Roof Snow Load (psf) (Equation 7.3-1 ASCE 7-16)	0.00	
Roof Snow Load (psf) (Equation 7.4-1 ASCE 7-16)	0.00	

Wall Dead Load		
Shear Wall (7/16 in thick plywood)	0.80	**ASCE 7-16*
Non-Structural Wall (3/8 in thick plywood)	0.60	**ASCE 7-16 T12.2-1*
2x6 studs (No. 1 DF-L)	1.35	**plf*

Floor Dead Load		
Plywood Subflooring	2.50	**ASCE Table 4.2-1*
Self-Wt of Joist	0.00	
Length of Floor Joist (ft)	12.0	
Spacing (in)	18.0	
Approximate self-weight (plf)	1.10	
Weight of singular joist (plf)	13.2	
Number of joists required	9.00	
Total Dead Load Self-Wt. (plf)	118.8	
Floor Vol(ft^3)	660.0	
Dead Load Self-Wt	5.56	
Total	**8.06**	

Floor Live Load		
Floor Live Load	30	**ASCE 7-16 T4-1*

Rain Load	
i (in/hr) (60 min/100 yr Primary - LA Plumbing Code 2022)	2.00
i (in/hr) (15 min/100 yr Secondary - ASCE 7-16 - NOAA	1.00
A of the roof (ft^2)	153.2
Primary Drainage System (Los Angeles Plumbing Code 2022)	3" Gutter at 1/16" per foot slope
Secondary Drainage System	Open Sided Roof
Q on the roof (gpm) (Equation C8.3-1 ASCE 7-16)	3.19
Lr (ft)	12
Ai/400 <= Lr (Equation C8.3-2)	Yes
Hydraulic head (in) (Negligible based on ASCE 7-16 C8.3)	0.00
Static Head (in) (Open sided roof has no static head)	0.00
R (psf) (equation 8.3-1 ASCE 7-16)	0.00

GARDEN EDUCATION CENTER - WIND LOADS

North-South Direction	
Exposure Category	B
h (ft)	14.0
L (ft)	10.0
B (ft)	12.0
Elevation (ft) (USGS - https://apps.nationalmap.gov/viewer/)	285.6
V (mph) (ATC Hazards Risk Cat. 1)	88.0
Ke (Table 26.9-1)	1.00
Kd (ASCE 7-16 Table 26.6-1)	0.85
Kz, h=0-15' (ASCE 7-16 Table 26.10-1)	0.57
Kzt (ASCE 7-16 26.8.2)	1.00
qi=0.00256KzKdKeKztV^2	9.61
L/B	0.83
h/L	1.40
Roof Angle	21.8

MWFRS Walls	*q (psf) at h (uses Kz)*	*Cp (ASCE 7-16 Figure 27.3-1)*	*G (ASCE C26.11.1)*	*+/-(GCpi) (ASCE 7-16 Table 26.13-1)*	*Just q or qi GCp*	*Pressures with -GCpi*	*Pressures with +Gcpi*
Windward, h=0-14'	9.61	0.80	0.85	0.18	6.53	8.26	8.26
Leeward L/B=0.833	9.61	-0.50	0.85	0.18	-4.08	-2.35	-2.35
Sidewalls	9.61	-0.70	0.85	0.18	-5.71	-3.99	-3.99

MWFRS Roof, h/L =1.4	*q (psf) at h (uses Kz)*	*Cp (ASCE 7-16 Figure 27.3-1)*	*G (ASCE C26.11.1)*	*+/-(GCpi) (ASCE 7-16 Table 26.13-1)*	*Just q or qi GCp*	*Pressures with -GCpi*	*Pressures with +Gcpi*
Windward	9.61	-0.63	0.85	0.18	-5.13	-3.40	-6.86
Leeward	9.61	-0.60	0.85	0.18	-4.90	-3.17	-6.63

Total Loads In N-S (psf)	
Walls, Windward, h=0-14'	8.26
Walls, Leeward	-2.35
Walls, Sidewalls	-3.99
Roof, Windward	-6.86
Roof, Leeward	-6.63

East-West Direction	
Exposure Category	B
h (ft)	14.0
L (ft)	12.0
B (ft)	10.0
Elevation (ft) (USGS - https://apps.nationalmap.gov/viewer/)	285.6
V (mph) (ATC Hazards Risk Cat. 1)	88.0
Ke (Table 26.9-1)	1.00
Kd (ASCE 7-16 Table 26.6-1)	0.85
Kz, h=0-15' (ASCE 7-16 Table 26.10-1)	0.57
Kzt (ASCE 7-16 26.8.2)	1.00
qi=0.00256KzKdKeKztV^2	9.61
L/B	1.20
h/L	1.17
Roof Angle	21.8
Roof Area (ft^2)	153.2
Reduction Factor	0.96

MWFRS Walls	*q(psf) at h (uses Kz)*	*Cp (ASCE 7-16 Figure 27.3-1)*	*G (ASCE C26.11.1)*	*+/-(GCpi) (ASCE 7-16 Table 26.13-1)*	*Just q or qi GCp*	*Pressures with -GCpi*	*Pressures with +Gcpi*
Windward, h=0-14'	9.61	0.80	0.85	0.18	6.53	8.26	4.80
Leeward L/B=1.2	9.61	-0.46	0.85	0.18	-3.76	-2.03	-5.48
Sidewalls	9.61	-0.70	0.85	0.18	-5.71	-3.99	-7.44

MWFRS Roof, h/L = 1.167	*q(psf) at h (uses Kz)*	*Cp (ASCE 7-16 Figure 27.3-1)*	*G (ASCE C26.11.1)*	*+/-(GCpi) (ASCE 7-16 Table 26.13-1)*	*Just q or qi GCp*	*Pressures with -GCpi*	*Pressures with +Gcpi*
Windward, 0'-7'	9.61	-1.25	0.85	0.18	-10.24	-8.51	-11.97
Windward, 7'-12'	9.61	-0.70	0.85	0.18	-5.71	-3.99	-7.44

Total Loads In E-W (psf)	
Walls, Windward, h=0-14'	8.26
Walls, Leeward	-5.48
Walls, Sidewalls	-7.44
Roof, Windward, 0'-7'	-11.97
Roof, Windward, 7'-14'	-7.44

Worst Case Load (psf)
-11.97

GARDEN EDUCATION CENTER - WIND LOADS CLADDING DESIGN

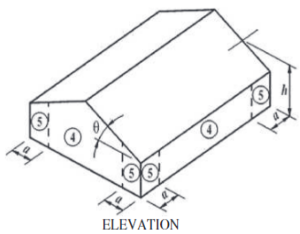
cladding design ch. 30 ASCE 7
SPDWS to check perpendicular strength requirement for wind on shear walls and on diaphragm

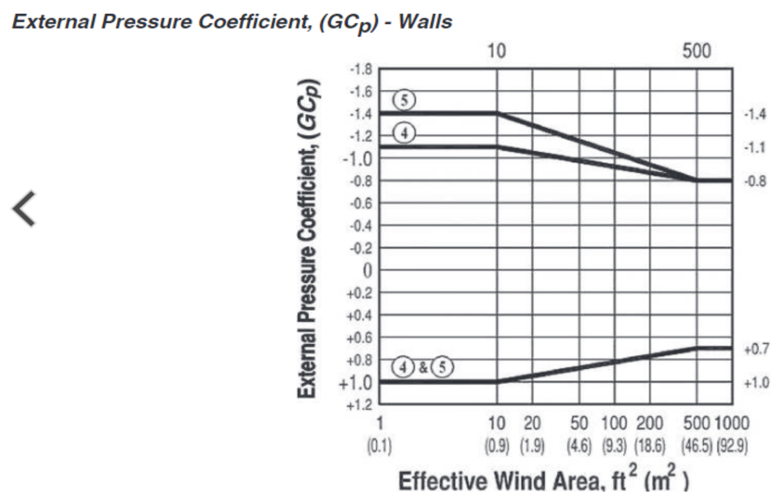
Wind Loads on Components and Cladding Parameters	
Building Type Main (ASCE 7-16 Section 30.1.1)	Part 1 - h<=60 ft and monoslope roof
Building Type Overhang (ASCE 7-16 Section 30.1.1)	Part 6 - overhangs
Buidling Conditions (ASCE 7-16 Section 30.1.2)	Satisfies Section 26.2
V (mph) (ATC Hazards Risk Cat. 1)	88
Ke (Table 26.9-1)	1
Kd (ASCE 7-16 Table 26.6-1)	0.85
Kz, h=0-15' (ASCE 7-16 Table 26.10-1)	0.57
Kzt (ASCE 7-16 26.8.2)	1
qi=0.00256KzKdKeKztV^2	9.60503808
Enclosure Classification	Enclosed
Minimum Design Wind Pressures (psf) (ASCE 7-16 Section 30.2.2)	16
Roof Angle (Degrees)	21.80140949
Mean Roof Height (ft)	12

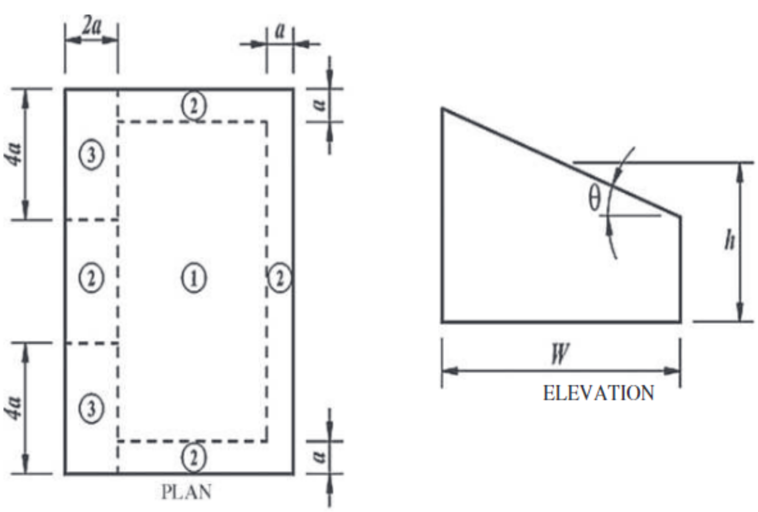
Wind Pressures on Wall Cladding in N-S and E-W Directions									
Wall Section	qh at 12 ft (psf)	qh (psf)	a (ft)	Effective Wind Area (ft^2)	+GCp	-GCp	GCpi	p with -GCp (psf)	p with +GCp (psf)
4 N-S	9.60503808	16	3	72	0.85	-0.93	0.18	-17.76	10.72
4 E-W	9.60503808	16	3	48	0.9	-0.97	0.18	-18.4	11.52
5	9.60503808	16	3	36	0.95	-1.2	0.18	-22.08	12.32
Maximum Wall Cladding Wind Pressure (psf)				-22.08					

Wind Pressures on Roof Cladding in N-S and E-W Directions									
Roof Section	qh at 12 ft (psf)	qh (psf)	a (ft)	Effective Wind Area (ft^2)	+GCp	-GCp	GCpi	p with -GCp (psf)	p with +GCp (psf)
1	0	16	3	18	0.37	-1.25	0.18	-22.88	3.04
2	0	16	3	54	0.35	-1.35	0.18	-24.48	2.72
3	0	16	3	72	0.3	-2.1	0.18	-36.48	1.92
Maximum Roof Cladding Wind Pressure (psf)				-36.48					

Check that Wall and Roof Cladding can Resist Perpendicular Wind Pressures			
Wall Cladding		Roof Cladding	
Material	Plywood Panels	*Material*	Polycarbonate
Thickness (in)	0.375	*Thickness (in)*	0.315
Nomial Uniform Load Capacity for 24 in Spacing (psf)	30	*Flexural Strength (psi)*	13500
Acceptable?	Yes	*Acceptable?*	Yes







GARDEN EDUCATION STRUCTURE - LRFD LOAD COMBINATIONS

Load Summary	Roof (psf)
Dead (D)	13.5
Live (L)	0
Roof Live (Lr)	19.2
Rain (R)	0
Snow (S)	0
Wind (W)	11.97
Seismic (Ev)	4.37
Seismic (Eh)	10.49
Seismic (Emh)	24.22
Seismic (Em)	19.85

LRFD Load Combinations per ASCE 7-16	Roof (psf)
1.4D	18.9
1.2D+1.6L+0.5Lr	25.8
1.2D+1.6L+0.5S	16.2
1.2D+1.6L+0.5R	16.2
1.2D+1.6Lr+L	46.92
1.2D+1.6S+L	16.2
1.2D+1.6R+L	16.2
1.2D+1.6Lr+0.5W	52.90
1.2D+1.6S+0.5W	22.18
1.2D+1.6R+0.5W	22.18
1.2D+W+L+0.5Lr	37.77
1.2D+W+L+0.5S	28.17
1.2D+W+L+0.5R	28.17
0.9D+W	24.12
1.2D+Ev+Eh+L+0.2S	31.06
0.9D-Ev+Eh	18.27
1.2D+Ev+Emh+L+0.2S	44.78
0.9D-Ev+Emh	32.00
Maximum Load Combination	**53**

GARDEN EDUCATION STRUCTURE - BUILDING WEIGHT CALCULATIONS

East and West Walls				
Distance from Origin, x (ft)	*Height at Origin (ft)*	*Angle of Roof (°)*	*Angle of Roof (Rad)*	*Height at x (ft)*
0.5	10	21.8	0.38	10.20
2	10	21.8	0.38	10.80
3.5	10	21.8	0.38	11.40
5	10	21.8	0.38	12.00
6.5	10	21.8	0.38	12.60
8	10	21.8	0.38	13.20
9.5	10	21.8	0.38	13.80
10	10	21.8	0.38	14.00

Member	X-Sectional Area (ft^2)	Height (ft)	Volume (ft^3)
S1	0.057	10.000	0.573
S2	0.057	10.200	0.584
S3	0.057	10.800	0.619
S4	0.057	11.400	0.653
S5	0.057	12.000	0.687
S6	0.057	12.600	0.722
S7	0.057	13.200	0.756
S8	0.057	13.800	0.791
S9	0.057	14.000	0.802

Total Volume (ft^3)
6.19

Roof	
Roof Dead Load (psf)	13.5
Area of Roof (ft^2)	153.2
Roof Wt. (lbs)	2069
Roof Wt. (kips)	2.07

Member Name	Dim. (ft)	Length (ft)	Width (ft)	Height (ft)	Area (ft^2)	Weight (psf)	Density (lb/ft^3)	Volume (ft^3)	Weight (lbs)	Qty.	Total Weight (lbs)
Rafters	2x6										
Edge Rafters	2x6										
Girders	2x12										
Columns/Studs (North)	2x6	0.125	0.458	14.00			33.00	0.802	26.47	9.00	238.2
Columns/Studs (South)	2x6	0.125	0.458	10.00			33.00	0.573	18.91	9.00	170.2
Floor Joist	2x6	0.125	0.458	12.00			33.00	0.688	22.69	11.00	249.6
Shear Wall Sheathing	0.03				239.70		37.50	7.49	280.90		280.9
Non-Structural Sheathing	0.03				190.00		37.50	5.94	222.66		222.7
Columns/Studs (East and West)							33.00	6.19	204.19		204.2
Roof Rafters	2x6	0.125	0.458	10.77			33.00	0.62	20.35	9.00	183.1
Roof Girders	4x10	0.292	0.771	12.00			33.00	2.70	89.03	2.00	178.1
Roof Sheathing		10.00	12.00		120.00	1.93					231.6
Wall Cladding	0.042				429.70		55.00	17.90	984.73		984.7

TOTAL WT. APPROX.	5012.0

New Seismic Wt.

GARDEN EDUCATION STRUCTURE - SEISMIC DESIGN CALCULATIONS

Seismic Design Parameters	
Building Occupancy Risk Category	I
I_e (Table 1.5-2)	1
Site Class (11.4.3 ASCE 7-16)	D
S_s (https://hazards.atcouncil.org)	2.022
S_1 (https://hazards.atcouncil.org)	0.721
F_a (11.4.4 and Table 11.4-1 ASCE 7-16)	1.2
F_v (Table 11.4-2 ASCE 7-16)	1.7
S_{ms} (Equation 11.4-1 ASCE 7-16)	2.426
S_{m1} (Equation 11.4-2 ASCE 7-16)	1.226
S_{DS} (Equation 11.4-3 ASCE 7-16)	1.618
S_{D1} (Equation 11.4-4 ASCE 7-16)	0.817
T_L (s) (https://hazards.atcouncil.org)	8
SDC (Tables 11.6-1 and 11.6-2 ASCE	D
Analytical Procedure (Table 12.6-1	ELF

Seismic Weight Calcs.	
Wt. of Roof (kips)	2.07
No. of External Studs	8.00
No. of Internal Studs	28.0
Total No. of Studs	36.0
Density of 2x6 stud (lb/cu. foot)	33.0
Vol. of North Wall Studs (cu. foot)	7.22
Vol. of South Wall Studs (cu. foot)	5.16
Vol. of East Wall Studs (cu. foot)	6.19
Vol. of WestWall Studs (cu. foot)	6.19
Wt. of Studs (lbs)	816.7
Wt. of Studs (kips)	0.82
Surface Area of North Wall (sq. ft.)	168.0
Surface Area of South Wall (sq. ft.)	120.0
Surface Area of East Wall (sq. ft.)	120.0
Surface Area of West Wall (sq. ft.)	120.0
Wt. of 8mm Polycarbonate Paneling (lb.	0.35
Wt. of Polycarbonate Paneling (lbs)	183.7
Wt. of Polycarbonate Paneling (kips)	0.18
Wt. of Shear Walls (kips)	0.28
Wt. of Non-Structural Sheathing (kips)	0.22
Wt. of Non-Structural Cladding (kips)	0.98
Seismic Weight (kips)	3.31

Seismic Load Effects and Combinations (Section 12.4 ASCE 7-16)	
SFRS	A15
R (Table 12.2-1 ASCE 7-16)	6.5
Cd (Table 12.2-1 ASCE 7-16)	4
p (Section 12.4.3.2 ASCE 7-16)	1.3
Overstrength Factor (Table 12.2-1 ASC	3
Ev (psf) (Equation 12.4-4a ASCE 7-16)	4.3686
Eh (psf) (Equation 12.4-3 ASCE 7-16)	10.49351947
Emh (psf) (Equation 12.4-7 ASCE 7-16)	24.21581415
Em (psf) (Equation 12.4.6 ASCE 7-16)	19.84721415

Seismic Base Shear Analysis per ELF	
H_{avg} (ft)	12
C_t (Table 12.8-2 ASCE 7-16)	0.02
x (Table 12.8-2 ASCE 7-16)	0.75
T_a (s) (Equation 12.8-7 ASCE 7-16)	0.13
C_s (12.8-2)	0.2489
C_s (12.8-3)	0.9749
C_s (12.8-5)	0.0712
C_s (12.8-6)	0.0555
Governing C_s (12.8.1.1 ASCE 7-16)	0.2489
W (k)	3.313179897
V_b (k) (Equation 12.8-1 ASCE 7-16)	0.824650476
Adjusted V_b (k) (11.4.8 ASCE 7-16)	1.236975714

Vertical Distribution of Seismic Forces per ELF (Section 12.8.3 ASCE 7-16)

Story	*k (Equation 12.8-12 ASCE 7-16)*	*Wx (k)*	*Hx (ft)*	*Wx(Hx^k)*	*Cvx*	*Fx (k)*
Roof	1.00	3.31	12.0	39.8	1.00	1.24

Horizontal Distribution of Forces per ELF (Section 12.8.4 ASCE 7-16)	
Story	V (k)
Roof	1.24

Overturning Moment (Section 12.8.5 ASCE 7-16)	
*M (k*ft)*	14.8

Shear Wall Sizes							
Wall	Quantity	Height (ft)	Base (ft)	h/b	h/b Acceptable for Reduced Shear?	2b/h	Reduced Base (ft)
North Wall	1	14	4	3.50	Yes	0.571429	2.285714
South Wall	2	10	3	3.33	Yes	0.6	1.8
West Wall	1	13.2	4	3.30	Yes	0.606061	2.424242
East Wall	1	13.2	4	3.30	Yes	0.606061	2.424242

Seismic Shear Strength Requirements				
Direction	*Base Shear (k)*	*Sum of Shear Wall Length (ft)*	*Shear Strength Requirement (plf)*	1.5*Shear Strength Requirement (plf)
N-S	1.2	3.6	343.6	515.4
E-W	1.2	4.8	255.1	382.7

Shear Wall Material Parameters	
Material	*Plywood Sheathing*
Wood Specification	STRUCTURAL 1
Thickness (in)	0.375
Minimum Nail Bearing Length in Framing and Blocking (in)	1.375
Panel Nail Edge Spacing (in)	6
Vs (plf)	645
Ga (k/in)	14

Shear Wall Chord Material Parameters	
Member name	Stud/Column
Material	No. 1 Douglas Fir Larch
Nominal Dimensions	2 by 6
Width (in)	1.5
Depth (in)	5.5
Area of Cross Section (in^2)	8.25
E (psi) (NDS Table 4a)	1700000

Seismic Hold Down Tension Requirements						
Wall	Quantity	Reduced Base (ft)	Height (ft)	Base Shear (k)	Overturning Moment (k*ft)	Tension Demand (k)
North Wall	1.00	2.29	14.00	1.24	6.73	2.94
South Walls	2.00	1.80	10.00	1.24	3.78	2.10
East Wall	1.00	2.42	13.20	1.24	8.16	3.37
West Wall	1.00	2.42	13.20	1.24	8.16	3.37

Seismic Hold Down Material	
Installation	Post Pour
Connection Materials	Wood to Concrete
SST Holdown Name	HTT4
Anchor Rod Diameter (in)	0.625
Wood Fasteners (in)	(18) #19 by 1.5" SD
Min Wood Member Size (in)	2 by 6
Allowable Tension Load (lb)	4455
Deflection at Highest Allowable Load (in)	0.112

Story Drift Determination (Section 12.8.6 ASCE 7-16)				
Story	*Deflection from Elastic Analysis*	*Deflection to Calculate Story Drift*	*Story Drift (in)*	*Allowable Drift (in) (0.02hxx Table 12.12-1 ASCE 7-16)*
Roof	0	0	0.72	2.88

Shear Wall Deflection					
Wall	*Deflection from Elastic Analysis*	*Deflection to Calculate Story Drift*	*Deflection (in)*	*Allowable Deflection (in) (0.02hxx Table 12.12-1 ASCE 7-16)*	*Deflection Acceptable?*
North Wall	0.6620483	2.6481932	2.648193239	3.36	Yes
South Walls	0.4297389	1.7189555	1.718955503	2.4	Yes
East Wall	0.452534	1.810136	1.810135986	3.168	Yes
West Wall	0.452534	1.810136	1.810135986	3.168	Yes

P-Delta Effects (Section 12.8.7 ASCE 7-16)	
Px	2.07
Delta	2.65
Theta	0.01
Consider P-Delta effects?	No
Beta	1.00
Maximum Theta	0.13
Exceed Maximum Theta?	No

Diaphragm Material Parameters	
Material	Polycarbonate Paneling
Thickness (in)	0.315
Flexural Yield Strength (psi)	13500
Shear Yield Strength (psi)	6000
Fasterner Spacing (in)	6

Diaphragm Design Forces (Section 12.10.1.1 ASCE 7-16)				
Story	Fpx (k) (Equation 12.10-1)	Fpx (k) (Equation 12.10-2)	Fpx (k) (Equation 12.10-3)	Govering Fpx (k)
Roof	1.24	1.07	2.14	1.24

Diaphragm Fastener Shear Force	
Direction	Loads on Diaphragm from Shear walls (lb/ft)
N-S	123.7
E-W	154.6

Collector Elements	
Material	No. 1 Douglas Fir Larch
Nominal Size	2 by 4
Deflection Limit	L/360
Maximum Horizontal Span (ft) (AWC Max Span Calculator)	7
Quantity	2 per collector
Locations	above all windows and doors

GARDEN EDUCATION STRUCTURE - SIZING INTERIOR RAFTERS

1. Interior Rafters (Reference: Example 6.19 Sawn-Beam Design Using LRFD, Design of Wood Structures 7th Edition)

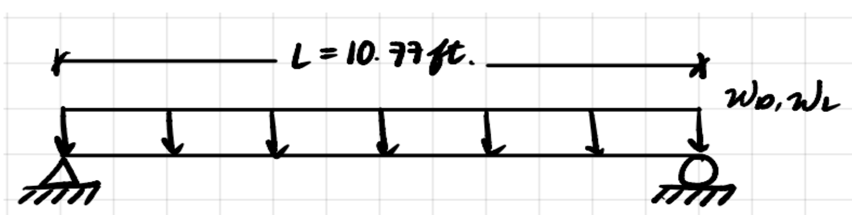
Assumptions:

Material	LVL (No. 1 Douglas Fir Larch)
Size	2x6

Dimension	(ft)	(in)
L	10.77	129.24
w	0.125	1.5
h	0.458333333	5.5
spacing	1.5	18
tributary width	1.5	18

	(ft^2)	(in^2)
Tributary Area	16.155	2326.32

a. LOADS



Load	Roof (psf)	Roof (plf)
Dead (D)	13.5	20.25
Live (L)	0	0
Roof Live (Lr)	19.2	28.8
Rain (R)	0	0
Snow (S)	0	0
Wind (W)	11.97	17.95
Seismic (Ev)		
Seismic (Eh)		0
Worst Case	53.00	79.50

Distributed Dead Load, wd (plf)	20.25
Distributed Live Load, wl (plf)	28.8

LRFD Load Combinations	
1.4D	28.4
1.2D+1.6L+0.5Lr	38.7
1.2D+1.6L+0.5S	24.3
1.2D+1.6L+0.5R	16.2
1.2D+1.6Lr+L	70.4
1.2D+1.6S+L	24.3
1.2D+1.6R+L	24.3
1.2D+1.6Lr+0.5W	79.4
1.2D+1.6S+0.5W	33.3
1.2D+1.6R+0.5W	33.3
1.2D+W+L+0.5Lr	56.6
1.2D+W+L+0.5S	42.2
1.2D+W+L+0.5R	42.2
0.9D+W	36.2
1.2D+Ev+Eh+L+0.2S	-
0.9D-Ev+Eh	-
Governing Load, wu (plf)	0

b. MOMENT DEMAND	
Moment Demand, Mu (k-in)	0.00
Moment Demand, Mu (ft-lb)	0.0

c. BENDING		
Reference Bending Design Value, Fb (psi)	1000	*NDS Supplementary Table 4a*
Reference Shear Design Value, Fv (psi)	180	*NDS Supplementary Table 4a*
Modulus of Elasticity, E (in^4)	1,700,000	*NDS Supplementary Table 4a*
Specific Gravity, G	0.5	*NDS Supplementary Table 4a*
Repetitive Factor, Cr	1.15	*Design of Wood Structures 7th Edition*
Sizing Factor, Cf	1.2	*Design of Wood Structures 7th Edition*
Moisture Content, Cm	1.0	*Design of Wood Structures 7th Edition*
Buckling Stiffness, Ct	1.0	*Design of Wood Structures 7th Edition*
Beam Stability, Cl	1.0	*Design of Wood Structures 7th Edition*
Incising Factor, Ci	1.0	*Design of Wood Structures 7th Edition*
Format Conversion Factor for Bending, Kf	2.5	

Nominal Bending Design Value, Fbxn (psi)	2540
Adjusted Bending Design Value, Fb' (psi)	2103
Adjusted Bending Design Value, Fb' (ksi)	2.10
Required Section Modulus, S (in^3)	0.00

Sizing Member (Comparing S)			
Size	S (in^3)	OK?	*Source*
2x6	7.56	YES	*NDS Supplementary Table 1b*
2x5	5.06	YES	*NDS Supplementary Table 1b*

Check Sizing Factor	
Sizing Factor. Cf (from Supp. Table)	1.3
OK?	YES

Area of Section, A (in^2)	8.25	*NDS Supplementary Table 1a*
Moment of Inertia	20.80	*Design of Wood Structures 7th Edition*

New Bending Design Value, Fb' (ksi)	2.28

MOMENT CHECK	
Moment Capacity, M' (k-in)	17.22
Moment Demand, Mu (k-in)	0.00
OK?	YES

SHEAR CHECK		
Buckling Stiffness, Ct	1.0	*Design of Wood Structures 7th Edition*
Moisture Content, Cm	1.0	*Design of Wood Structures 7th Edition*
Incising Factor, Ci	1.0	*Design of Wood Structures 7th Edition*
Resistance Factor for Shear, φv	0.75	*Design of Wood Structures 7th Edition*
Conversion Factor for Shear, Kf	2.88	*Design of Wood Structures 7th Edition*
λ	0.80	*Design of Wood Structures 7th Edition*

Nominal Shear Design Value, Fvn (psi)	518
Adjusted Shear Design Value, F'vn (psi)	311
Adjusted Shear Design Value, F'vn (ksi)	0.311

Shear Demand, Vu (lbs)	0
Shear Demand, Vu (kips)	0.000
Shear Capacity, V'n (kips)	1.71
OK?	YES

DEFLECTION CHECK	
Buckling Stiffness, Ct	1.0
Moisture Content, Cm	1.0
Incising Factor, Ci	1.0
Adjusted Modulus of Elasticity, E' (psi)	1700000

Design δ, live (in)	0.247
Allowable δ, live (in)	0.359
OK? (Live Load Deflection)	YES
Design δ, total (in)	0.416
Allowable δ, total (in)	0.5385
OK? (Dead Load Deflection)	YES

GARDEN EDUCATION STRUCTURE - SIZING EDGE RAFTERS

2. Edge Rafters (Reference: Example 6.19 Sawn-Beam Design Using LRFD, Design of Wood Structures 7th Edition)

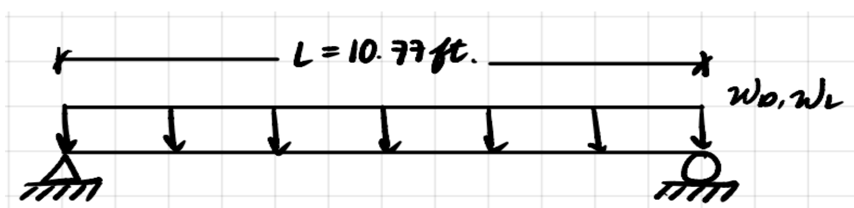
Assumptions:

Material	No. 1 Douglas Fir Larch
Size	2x6

Dimension	(ft)	(in)
L	10.77	129.24
w	0.125	1.5
h	0.458333333	5.5
spacing	0.5	6
tributary width	0.25	3

	(ft^2)	(in^2)
tributary area	2.6925	387.72

a. LOADS



Load	Roof (psf)	Roof (plf)
Dead (D)	13.5	10.125
Live (L)	0	0
Roof Live (Lr)	19.2	14.4
Rain (R)	0	0
Snow (S)	0	0
Wind (W)	11.96573507	8.974301304
Seismic (Ev)		0
Seismic (Eh)		0
Worst Case	51.10286754	38.32715065

Distributed Dead Load, wd (plf)	3.375
Distributed Live Load, wl (plf)	4.8

LRFD Load Combinations	
1.4D	4.725
1.2D+1.6L+0.5Lr	6.45
1.2D+1.6L+0.5S	0
1.2D+1.6L+0.5R	0
1.2D+1.6Lr+L	0
1.2D+1.6S+L	0
1.2D+1.6R+L	0
1.2D+1.6Lr+0.5W	0
1.2D+1.6S+0.5W	0
1.2D+1.6R+0.5W	0
1.2D+W+L+0.5Lr	0
1.2D+W+L+0.5S	0
1.2D+W+L+0.5R	0
0.9D+W	0
1.2D+Ev+Eh+L+0.2S	
0.9D-Ev+Eh	
Governing Load, wu (plf)	6.45

b. MOMENT DEMAND	
Moment Demand, Mu (k-in)	1.12
Moment Demand, Mu (ft-lb)	93.5

c. BENDING		
Reference Bending Design Value, Fb (psi)	1000	*NDS Supplementary Table 4a*
Reference Shear Design Value, Fv (psi)	180	*NDS Supplementary Table 4a*
Modulus of Elasticity, E (in^4)	1,700,000	*NDS Supplementary Table 4a*
Specific Gravity, G	0.5	*NDS Supplementary Table 4a*
Repetitive Factor, Cr	1.15	*Design of Wood Structures 7th Edition*
Sizing Factor, Cf (initially assumed)	1.2	*Design of Wood Structures 7th Edition*
Moisture Content, Cm	1.0	*Design of Wood Structures 7th Edition*
Buckling Stiffness, Ct	1.0	*Design of Wood Structures 7th Edition*
Beam Stability, Cl	1.0	*Design of Wood Structures 7th Edition*
Incising Factor, Ci	1.0	*Design of Wood Structures 7th Edition*

Nominal Bending Design Value, Fbxn (psi)	2880
Adjusted Bending Design Value, Fb' (psi)	2385
Adjusted Bending Design Value, Fb' (ksi)	2.38
Required Section Modulus, S (in^3)	0.47

Sizing Member (Comparing S)				
Size	S (in^3)	A (in^2)	OK?	
2x6	7.56	8.25	YES	*NDS Supplementary Table 1b*
2x5	5.06	6.75	YES	*NDS Supplementary Table 1b*
2x4	3.06	5.25	YES	*NDS Supplementary Table 1b*

Check Sizing Factor	
Sizing Factor. Cf (from Supp. Table)	1.3
OK?	YES

Area of Section, A (in^2)	5.25	*NDS Supplementary Table 1a*
Moment of Inertia	20.80	*Design of Wood Structures 7th Edition*

New Bending Design Value, Fb' (ksi)	2.58

MOMENT CHECK	
Moment Capacity, M' (k-in)	19.53
Moment Demand, Mu (k-in)	1.12
OK?	YES

SHEAR CHECK	
Buckling Stiffness, Ct	1.0
Moisture Content, Cm	1.0
Incising Factor, Ci	1.0
Resistance Factor for Shear, φv	0.75
Conversion Factor for Shear, Kf	2.88
λ	0.80

Nominal Shear Design Value, Fvn (psi)	518
Adjusted Shear Design Value, F'vn (psi)	311
Adjusted Shear Design Value, F'vn (ksi)	0.311

Shear Demand, Vu (lbs)	35
Shear Demand, Vu (kips)	0.035
Shear Capacity, V'n (kips)	1.09
OK?	YES

DEFLECTION CHECK	
Buckling Stiffness, Ct	1.0
Moisture Content, Cm	1.0
Incising Factor, Ci	1.0
Adjusted Modulus of Elasticity, E' (psi)	1700000

Design δ, live (in)	0.041
Allowable δ, live (in)	0.359
OK? (Live Load Deflection)	YES
Design δ, total (in)	0.012
Allowable δ, total (in)	0.5385
OK? (Dead Load Deflection)	YES

GARDEN EDUCATION STRUCTURE - SIZING GIRDERS

3. Girders

Material	LVL (No. 1 Douglas Fir Larch)
Size	2x12

Dimension	(ft)	(in)
L	12	144
w		
h		
spacing		
tributary width, int.	1.5	18
tributary width, ext.		9

	(ft^2)	(in^2)
tributary area	18	2592

a. LOADS	
Distributed Dead Load, wD (plf)	72.7
Distributed Live Load, wL (plf)	103.4
Int. Governing Load for Rafters, wu (plf)	0.00
Ext. Governing Load for Rafters, wu (plf)	6.45
Tributary Width (ft)	5.39
Distributed Load (plf)	285.4
b. MOMENT DEMAND	
Moment Demand, Mu (k-in)	61.65
Moment Demand, Mu (ft-lb)	5137.3

c. BENDING		
Reference Bending Design Value, Fb (psi)	1000	*NDS Supplementary Table 4a*
Reference Shear Design Value, Fv (psi)	180	*NDS Supplementary Table 4a*
Modulus of Elasticity, E (in^4)	1,700,000	*NDS Supplementary Table 4a*
Specific Gravity, G	0.50	*NDS Supplementary Table 4a*
Repetitive Factor, Cr	1.15	*Design of Wood Structures 7th Edition*
Sizing Factor, Cf	1.00	*Design of Wood Structures 7th Edition*
Moisture Content, Cm	1.00	*Design of Wood Structures 7th Edition*
Buckling Stiffness, Ct	1.00	*Design of Wood Structures 7th Edition*
Beam Stability, Cl	1.00	*Design of Wood Structures 7th Edition*
Incising Factor, Ci	1.00	*Design of Wood Structures 7th Edition*
Format Conversion Factor for Bending, Kf	2.54	

Nominal Bending Design Value, Fbxn (psi)	2541
Adjusted Bending Design Value, Fb' (psi)	1753

Adjusted Bending Design Value, Fb' (ksi)	1.75

Required Section Modulus, S (in^3)	35.2

Sizing Member (Comparing S)			
Size	S (in^3)	OK?	Source
4x10	49.9	YES	YES
6x8	51.6	YES	YES

Check Sizing Factor	
Sizing Factor. Cf (from Supp. Table)	1.2
OK?	YES

Area of Section, A (in^2)	32.4	*NDS Supplementary Table 1a*
Moment of Inertia (in^4)	230.8	*NDS Supplementary Table 1a*

New Bending Design Value, Fb' (ksi)	2.10

MOMENT CHECK	
Moment Capacity, M' (k-in)	105.0
Moment Demand, Mu (k-in)	61.6
OK?	YES

SHEAR CHECK		
Buckling Stiffness, Ct	1.00	*Design of Wood Structures 7th Edition*
Moisture Content, Cm	1.00	*Design of Wood Structures 7th Edition*
Incising Factor, Ci	1.00	*Design of Wood Structures 7th Edition*
Resistance Factor for Shear, φv	0.75	*Design of Wood Structures 7th Edition*
Conversion Factor for Shear, Kf	2.88	*Design of Wood Structures 7th Edition*
λ	0.80	*Design of Wood Structures 7th Edition*

Nominal Shear Design Value, Fvn (psi)	518
Adjusted Shear Design Value, F'vn (psi)	311
Adjusted Shear Design Value, F'vn (ksi)	0.311

Shear Demand, Vu (lbs)	1537
Shear Demand, Vu (kips)	1.537
Shear Capacity, V'n (kips)	6.71
OK?	YES

DEFLECTION CHECK	
Buckling Stiffness, Ct	1.00
Moisture Content, Cm	1.00
Incising Factor, Ci	1.00
Adjusted Modulus of Elasticity, E' (psi)	1700000

Design δ, live (in)	0.123
Allowable δ, live (in)	0.400
OK? (Live Load Deflection)	YES
Design δ, total (in)	0.209
Allowable δ, total (in)	0.600
OK? (Dead Load Deflection)	YES

GARDEN EDUCATION STRUCTURE - SIZING CEILING JOISTS

4. Cieling Joists (Example 7.8 Sawn Lumber Column Using LRFD, Design of Wood Structures 7th Edition)

DL (psf)	*LL (psf)*	*Tributary Area (ft^2)*	*Reduced Live Load, Lr (psf)*	*Governing Live Load, LL (psf)*	*Dead Point Load, PD (kips)*	*Live Point Load, PL (kips)*	*Combined Point Load, Pu (kips)*
13.5	20	#REF!	19.2	19.2	#REF!	#REF!	#REF!

Trial 1	
Properties	
Size	2 x 6
l (ft)	2
ϕs = resistance factor for stability	0.85
ϕc = resistance factor for compression	0.90
Fc (psi)	1550
Conversion Factor for Shear, Kf	1.76
λ = time effect factor	0.80
Size Factor, CF	1.10
Repetitive Factor, Cr	1.15
Moisture Content, Cm	1.00
Buckling Stiffness, Ct	1.00
Beam Stability, Cl	1.00
Incising Factor, Ci	1.00
CT	1.00
Emin (psi)	660000
dx (in)	5.50
dy (in)	1.50
A (in^2)	8.25
c = buckling and crushing interaction factor for columns	0.80

Fcn = Nominal Compression Design Value (psi)	2728

Emin,n = Emin*Kf (ksi)	1161.6
Emin,n = adjusted LRFD modulus of elasticity for column buckling	987.36

Column Capacity (l/D)max = (Ke*l)/dy	
Ke (unbraced factor ?)	1
l (in)	24
dy	1.5
Column Capacity (l/D)max	16

Emin,n	1161600
E'min = Emin(Cm)(Ct)(CT)(Ci)	660000
FcEn = nominal Euler critical buckling stress for columns =	2.119219
Fcn* = limiting LRFD compressive design value in column (ksi)	2.160576

Fcn' = compression value	
FcEn/Fcn*	0.980858
1+(FcEn/Fcn*)/2c	1.613036
(1+(FcEn/Fcn*)/2c)^2	2.601886
(FcEn/Fcn*)/c	1.226073
CP	0.440086
Fcn' (ksi)	0.348548

Pn = compresion = Fcn'*A	2.875519
CHECK (Pn>Pu?)	#REF!

Use 2 x 6 columns No. 1 DF-L

GARDEN EDUCATION STRUCTURE - SIZING WALL STUDS (N/S)

North and South Stud Walls. (Example 7.19 Combined Bending and Compression in a Stud Wall Using LRFD)

Design Values in Accordance with NDS.

Properties	
Width of Wall (ft)	12
Width of Adjacent Wall (ft)	10
Tributary Width of framing to wall (ft)	5
Length of Studs (ft)	10

1. Gravity Loads	
Roof Dead Load (psf)	13.5
Roof Live Load (psf)	19.2

Lateral Force, W (psf)	11.97

Applicable LRFD load combinations		λ
1.4D	18.9	0.6
1.2D+1.6L+0.5Lr	25.8	0.8
1.2D+1.6Lr+0.5W	52.90	0.8
1.2D+W+L+0.5Lr	37.77	1
Max Load Combo (psf)	53	

2. Select a Trial Size.	2x6
Actual thickness (in)	1.5
Actual depth (in)	5.5
Material	DF-L No.1
dx (in)	5.5
dy (in)	1.5

Nominal Values		
Kf (bending)	2.54	*NDA Supplement Table 4A*
Kf (parallel compression)	2.4	
Kf (perpendicular compression)	1.67	
Kf (modulus of elasticity)	1.76	
Fb (psi)	1000	*NDA Supplement Table 4A*
Fbn (psi)	2540	
Fc (psi)	1500	
Fcn (psi)	3600	*NDA Supplement Table 4A*
Fc| (psi)|	625	
Fc|n (psi)	1043.75	*NDA Supplement Table 4A*
Emin (ksi)	620000	

Emin,n (ksi)	1091200	NDA Supplement Table 4A
ϕs = resistance factor	0.85	
Moisture Content, Cm	1.0	
Buckling Stiffness, Ct	1.0	
Incising Factor, Ci	1.0	
λ	0.8	
c	0.8	
ϕc = resistance factor for compression	0.9	
Cp	0.454	
Cb	1.25	

Size Factors	
Cf for bending	1.3
Cf for compression parallel to grain	1.1

Section Properties	
A (in^2)	8.25
S (in^3)	7.56

Load Case 1: Gravity Loads	
Tributary Width of framing to wall (ft)	5
Dead Loads	
Roof Dead Load, wD (plf)	67.5
Live Loads	
Roof Live Load, wL (plf)	96

Load Combinations (kips)	
1.4D	0.095
1.2D+1.6L+0.5Lr	0.129
1.2D+1.6Lr+0.5L	0.235
Max Load Combo (kips)	0.235

Column Capacity about weak axis (le/d)	0	because of sheathing
Column Capcity about the x-axis (le/d),max	21.8	
E'min,n	927.5	

FcEn (ksi)	1.60
F*cn (ksi)	2.85
FcEn/F*cn	0.56
1+(FcEn/Fcn*)/2c	1.35
(1+(FcEn/Fcn*)/2c)^2	1.83
(FcEn/Fcn*)/c	0.70
CP	0.29
Fcn' (ksi)	1.62

Pn = compresion = Fcn'*A	13.348962
CHECK (Pn>Pu?)	YES

Bearing of Stud on Wall Plates	
Bearing length, lb (in)	1.50
Cb	1.25
F'c|n (ksi)	1.17
P'n (kips)	9.69
CHECK (P'n>Pu?)	YES

Vertical Loads OK.

Load Case 2: Gravity Loads + Lateral Forces	
BENDING	
Wind Load (psf)	11.97
Raft Spacing (in)	18.00
Raft Spacing (ft)	1.50
Distributed Wind Load, wW (plf)	17.95
0.5 Wind Load (plf)	8.97
Moment Capacity for Wind Load, Mu (ft-lb)	224.4
Moment Capacity for Wind Load, Mu (in-k)	2.69
fbu (ksi)	0.36

CL	1
Lamda	1
Repetitive Factor, Cr	1.15
ϕb = resistance factor for bending	0.85
CF	1.30
F'bn (ksi)	3.23
M'n (in-k)	24.40
CHECK (M'n > Mu?)	YES

OK

AXIAL	
Combo 1: 1.2wD + 1.6wL+ 0.5wW	243.6
Combo 2: 1.2wD + 1.0W+ 0.5WL	146.9
Rafter Tributary Width (in)	1.50
Pu for Combo 1, Pu (kips)	0.365
fcu for Load Combo 1 (ksi)	0.044
Pu for Combo 2, Pu (kips)	0.220
fcu for Load Combo 2 (ksi)	0.027
λ for Load Combo 1	0.80
λ for Load Combo 2	1.00
Slenderness Ratio (le/d), MAX = (le/d)x	21.82
FcEn	1.60
Combo 1: 1.2wD + 1.6wL+ 0.5wW	
Cp	0.45

F'cn	1.62	
Pn'	13.35	
CHECK (Pn'>Pu?)	YES	
Combo 2: 1.2wD + 1.0W+ 0.5WL		
F∗cn=Fcn(ϕc)(λ)(CM)(Ct)(CF)(Ci)	3.564	
FcEn/F*cn	0.44938678	
1+(FcEn/Fcn*)/2c	0.905866737	
(1+(FcEn/Fcn*)/2c)^2	0.820594546	
(FcEn/Fcn*)/c	0.561733475	
CP	0.397082823	
Fcn' (ksi)	1.415203183	
Pcn'	11.67542626	
CHECK (Pcn'>Pu?)	YES	OK

COMBINED STRESS		
Simplified Interaction Formula		
FcExn = FcEn	1.601614483	
(fcuF'cn)^2+fbxuF'bxn(1−fcu/FcExn)≤1.0	1	
Combo 1: 1.2wD + 1.6wL+ 0.5wW		
fcu (ksi)	0.044286237	
F'cu	1.17421875	
Wind Load (psf)	11.97	
Distributed Wind Load, wW (plf)	17.94860261	
Mu from Wind (in-k)	2.692290391	
fbxu (ksi)	0.356123068	
F'bxn (ksi)	3.227705	
(fcu/F'cn)^2	0.001422458	
(1/(1-fcu/FcExn))	1.028437317	
(fbxu/F'bxn)	0.110333214	
Axial Stress Check	0.114893253	
CHECK Axial Stress < 1?	YES	OK
Combo 2: 1.2wD + 1.0W+ 0.5WL		
fcu (ksi)	0.026717928	
F'cn	1.618056	
fbxu (ksi)	0.356123068	
F'bxn (ksi)	3.227705	
(fcu/F'cn)^2	0.000272658	
(1/(1-fcu/FcExn))	1.016964878	
(fbxu/F'bxn)	0.110333214	
Axial Stress Check	0.112477662	
CHECK Axial Stress < 1?	YES	

Use 2x6 Columns No.1 DF-L

GARDEN EDUCATION STRUCTURE - SIZING WALL STUDS (E/W)

East and West Stud Walls. (Example 7.19 Combined Bending and Compression in a Stud Wall Using LRFD)
Design Values in Accordance with NDS.

Properties	
Width of Wall (ft)	10
Width of Adjacent Wall (ft)	12
Tributary Width of framing to wall (ft)	6
Length of Studs (ft)	10

1. Gravity Loads	
Roof Dead Load (psf)	13.5
Roof Live Load (psf)	19.2
Lateral Force, W (psf)	11.97

Applicable LRFD load combinations		λ
1.4D	18.9	0.6
1.2D+1.6L+0.5Lr	25.8	0.8
1.2D+1.6Lr+0.5W	52.90	0.8
1.2D+W+L+0.5Lr	37.77	1
Max Load Combo (psf)	53	

2. Select a Trial Size.	2x6
Actual thickness (in)	1.5
Actual depth (in)	5.5
Material	DF-L No.1
dx (in)	5.5
dy (in)	1.5

Nominal Values		
Kf (bending)	2.54	*NDA Supplement Table 4A*
Kf (parallel compression)	2.4	
Kf (perpendicular compression)	1.67	
Kf (modulus of elasticity)	1.76	
Fb (psi)	1000	*NDA Supplement Table 4A*
Fbn (psi)	2540	
Fc (psi)	1500	
Fcn (psi)	3600	*NDA Supplement Table 4A*
Fc| (psi)|	625	
Fc|n (psi)	1043.75	*NDA Supplement Table 4A*
Emin (ksi)	620000	
Emin,n (ksi)	1091200	*NDA Supplement Table 4A*

φs = resistance factor	0.85
Moisture Content, Cm	1.0
Buckling Stiffness, Ct	1.0
Incising Factor, Ci	1.0
λ	0.8
c	0.8
φc = resistance factor for compression	0.9
Cp	0.454
Cb	1.25

Size Factors	
Cf for bending	1.3
Cf for compression parallel to grain	1.1

Section Properties	
A (in^2)	8.25
S (in^3)	7.56

Load Case 1: Gravity Loads	
Tributary Width of framing to wall (ft)	6

Dead Loads	
Roof Dead Load, wD (plf)	81
Live Loads	
Roof Live Load, wL (plf)	115.2

Load Combinations (kips)	
1.4D	0.113
1.2D+1.6L+0.5Lr	0.155
1.2D+1.6Lr+0.5L	0.282
Max Load Combo (kips)	0.282

Column Capacity about weak axis (le/d)	0.00	because of sheathing
Column Capcity about the x-axis (le/d),max	21.82	
E'min,n	927.52	
FcEn (ksi)	1.60	
F*cn (ksi)	2.85	
FcEn/F*cn	0.56	
1+(FcEn/Fcn*)/2c	1.35	
(1+(FcEn/Fcn*)/2c)^2	1.83	
(FcEn/Fcn*)/c	0.70	
CP	0.29	
Fcn' (ksi)	1.62	
Pn = compresion = Fcn'*A	13.35	
CHECK (Pn>Pu?)	YES	

Bearing of Stud on Wall Plates		
Bearing length, lb (in)	1.50	
Cb	1.25	
F'c|n (ksi)	1.17	
P'n (kips)	9.69	
CHECK (P'n>Pu?)	YES	Vertical Loads OK.

Load Case 2: Gravity Loads + Lateral Forces		
BENDING		
Wind Load (psf)	11.97	
Raft Spacing (in)	18.00	
Raft Spacing (ft)	1.50	
Distributed Wind Load, wW (plf)	17.95	
0.5 Wind Load (plf)	8.97	
Moment Capacity for Wind Load, Mu (ft-lb)	224.36	
Moment Capacity for Wind Load, Mu (in-k)	2.69	
fbu (ksi)	0.36	
CL	1.00	
Lamda	1.00	
Repetitive Factor, Cr	1.15	
φb = resistance factor for bending	0.85	
CF	1.30	
F'bn (ksi)	3.23	
M'n (in-k)	24.40	
CHECK (M'n > Mu?)	YES	OK
AXIAL		
Combo 1: 1.2wD + 1.6wL+ 0.5wW	290.49	
Combo 2: 1.2wD + 1.0W+ 0.5WL	172.75	
Rafter Tributary Width (in)	1.50	
Pu for Combo 1, Pu (kips)	0.44	
fcu for Load Combo 1 (ksi)	0.05	
Pu for Combo 2, Pu (kips)	0.26	
fcu for Load Combo 2 (ksi)	0.03	
λ for Load Combo 1	0.80	
λ for Load Combo 2	1.00	
Slenderness Ratio (le/d), MAX = (le/d)x	21.82	
FcEn	1.60	
Combo 1: 1.2wD + 1.6wL+ 0.5wW		
Cp	0.45	
F'cn	1.62	
Pn'	13.35	
CHECK (Pn'>Pu?)	YES	
Combo 2: 1.2wD + 1.0W+ 0.5WL		
F*cn=Fcn(φc)(λ)(CM)(Ct)(CF)(Ci)	3.564	
FcEn/F*cn	0.449	

1+(FcEn/Fcn*)/2c	0.906	
(1+(FcEn/Fcn*)/2c)^2	0.821	
(FcEn/Fcn*)/c	0.562	
CP	0.397	
Fcn' (ksi)	1.415	
Pcn'	11.675	
CHECK (Pcn'>Pu?)	YES	OK

COMBINED STRESS		
Simplified Interaction Formula		
FcExn = FcEn	1.60	
(fcuF′cn)^2+fbxuF′bxn(1−fcu/FcExn)≤1.0	1.00	
Combo 1: 1.2wD + 1.6wL+ 0.5wW		
fcu (ksi)	0.05	
F'cu	1.17	
Wind Load (psf)	11.97	
Distributed Wind Load, wW (plf)	17.95	
Mu from Wind (in-k)	2.69	
fbxu (ksi)	0.36	
F'bxn (ksi)	3.23	
(fcu/F'cn)^2	0.00	
(1/(1-fcu/FcExn))	1.03	
(fbxu/F'bxn)	0.11	
Axial Stress Check	0.12	
CHECK Axial Stress < 1?	YES	OK
Combo 2: 1.2wD + 1.0W+ 0.5WL		
fcu (ksi)	0.03	
F'cn	1.62	
fbxu (ksi)	0.36	
F'bxn (ksi)	3.23	
(fcu/F'cn)^2	0.00	
(1/(1-fcu/FcExn))	1.02	
(fbxu/F'bxn)	0.11	
Axial Stress Check	0.11	
CHECK Axial Stress < 1?	YES	

Use 2x6 Columns No.1 DF-L

GARDEN EDUCATION STRUCTURE - SIZING FLOOR JOISTS

https://www.huduser.gov/publications/pdf/res2000_3.pdf
Page 52

Properties		
LL (psf)	30	ASCE 7-16
DL (psf)	8.06	
L (ft)	12	
Joist Size	2x8	
Trial Joist Species and Grade	No.1 DF-L	
Joist Spacing (in) n	18	

Tabulated Design Table (NDS Tables 4A and 1B)	
Bending, Fb (psi)	1200
Shear Parallel to Grain, Fv (psi)	95
Compression Perpendicular to Grain, Fc| (psi)	625
Modulus of Elasticity, E (psi)	1800000
Ixx (in^4)	47.63
Sxx (in^3)	13.14
b (in)	1.5
d (in)	7.25
Area (in^2)	10.88

Lumber Property Adjustments and Adjusted Design Values (NDS 5.2.3 and 5.2.4)	
Load duration factor, Cd	0.9
Cr	1.15
CF	1.1
CL	1
CH	2
Cb	1
Fb'	1366.2
Fv'	171
Fc|	625
E'	1800000

1. Calculate the Applied Load, W

W = (joist spacing)(D+L) (plf)	57.08

2. Determine Bending Stress

Mmax = wL^2/8 (ft-lb)	1027.5
Fb = M/S (psi)	938.3561644

3. Determine Horizontal Shear Stress

Vmax = wL/2	342.5
fv = 3V/2A	47.21966912

4. Determine Bearing Stress

R1 = R2 = Vmax	342.5
fc| = R/Ab	114.1666667

5. Determine minimum Modulus of Elasticity due to deflection criteria.

ρmax, live = 5wL^4/384EI -> Emin = ?	141482/E
ρall, live = L/360	0.4
ρmax<ρall (solve for E,min)	353705

6. Determine minimum modulus of elasticity due to vibration.

Deflection check is assumed to provide adequate vibration control.

7. Determine minimum required unadjusted

Bending, Fb (psi)	
Fb,min	824.2039213

Horizontal Shear fv<Fv'	
Fv, min	26.23314951

Bearing fc|<Fc|'	
Fc|,min	114.1666667

Minimum unadjusted tabulated properties required	
Bending, Fb (psi)	824.2039213
Shear Parallel to Grain, Fv (psi)	26.23314951
Compression Perpendicular to Grain, Fc| (psi)	114.1666667
Modulus of Elasticity, E (psi)	353705

CHECK (ρmax > ρall)	
Fb	YES
Fv	YES
Fc|	YES
E'	YES

Use 2x6 Columns No.1 DF-L

GARDEN EDUCATION STRUCTURE - FOUNDATION DESIGN

Soil Properties		
Classification	SM	
N	23.3	blows
moist unit weight	120.0	pcf
c	0.0	psf
approx. friction angle	39.0	degrees

Bearing Capacity Calculations			
Bearing Capacity Calcs - Terzaghi			
a	5.1		
Nq	70.2		
Nc	85.6		
Ny	198.8		
Kpy	298.0		
Shape	sc	sy	
strip	1	1	
round	1.3	0.6	
square	1.3	0.8	
B	1	ft	(Table 1809.7)
L	12	ft	
D	1	ft	
q_bar	120		
q_ult	20351.1	psf	
wall load	601.5	psf	
q_allow	721.5		
F.S.	28.2		

Bearing Capacity Calcs - Meyerhoff		
Nq	55.6	
Nc	67.6	
Ny	76.7	
2tan(friction angle)(1-sin(f	0.2	
Kp	4.4	
sc	1.1	
sq	1.0	
sy	1.0	
dc	1.4	
dq	1.2	
dy	1.2	
q_ult	14136.9	psf
wall load	601.5	psf
q_allow	721.5	
F.S.	19.6	

Immediate Settlement Calculations		
B	1.0	ft
B'	0.5	ft
L	12.0	ft
L'	6.0	ft

M	12.0	
H	5.0	
N	10.0	

I1	0.8
I2	0.1

u	0.3	
d_borings	27.0	
o'v	3240.0	
CN	0.8	
N60	23.3	
CE	1.1	
N55	25.5	
Es	12945.5	
	9436.4	
	11190.9	kPa

Is	0.8
L/B	12.0
D/B	1.0
If	0.9
m	4.0
qo	41.8

delta_H	0.0049

GARDEN EDUCATION STRUCTURE - FOUNDATION DESIGN

Soil Properties		
Classification	SM	
N	23.3	blows
moist unit weight	120.0	pcf
c	0.0	psf
approx. friction angle	39.0	degrees

Bearing Capacity Calculations			
Bearing Capacity Calcs - Terzaghi			
a	5.1		
Nq	70.2		
Nc	85.6		
Ny	198.8		
Kpy	298.0		
Shape	sc	sy	
strip	1	1	
round	1.3	0.6	
square	1.3	0.8	
B	1	ft	(Table 1809.7)
L	12	ft	
D	1	ft	
q_bar	120		
q_ult	20351.1	psf	
wall load	601.5	psf	
q_allow	721.5		
F.S.	28.2		

Bearing Capacity Calcs - Meyerhoff		
Nq	55.6	
Nc	67.6	
Ny	76.7	
2tan(friction angle)(1-sin(f	0.2	
Kp	4.4	
sc	1.1	
sq	1.0	
sy	1.0	
dc	1.4	
dq	1.2	
dy	1.2	
q_ult	14136.9	psf
wall load	601.5	psf
q_allow	721.5	
F.S.	19.6	

Immediate Settlement Calculations		
B	1.0	ft
B'	0.5	ft
L	10.0	ft
L'	5.0	ft

M	0.8
H	0.1
N	0.2

I1	0.8
I2	0.2

u	0.3	
d_borings	27.0	
o'v	3240.0	
CN	0.8	
N60	23.3	
CE	1.1	
N55	25.5	
Es	12945.5	
	9436.4	
	11190.9	kPa

Is	0.835
L/B	10.0
D/B	1.0
If	0.9
m	4.0
qo	50.1

delta_H	0.0059

APPENDIX A-2

RAINWATER COLLECTION CISTERNS STRUCTURAL CALCULATIONS

RAIWATER COLLECTION CISTERNS - SEISMIC DESIGN

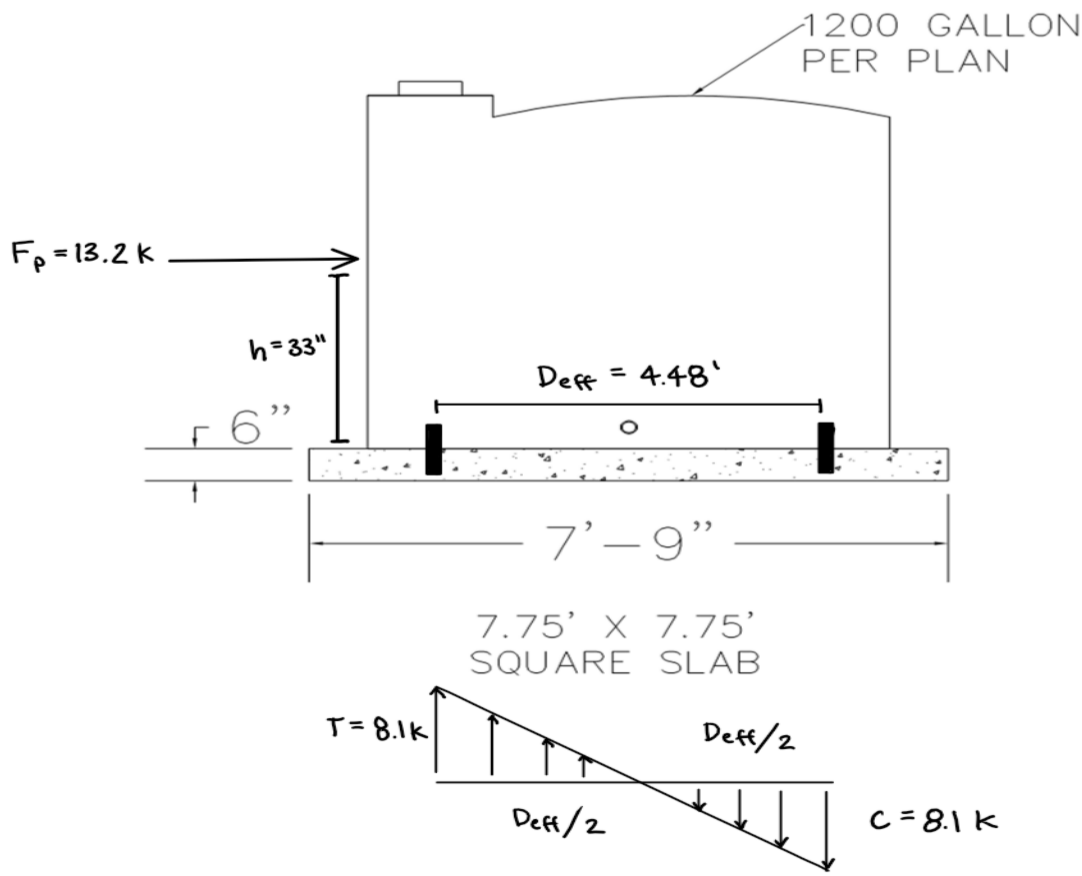
Seismic Design Parameters for Site	
Building Occupancy Risk Category (Table 1.5-1 ASCE 7-16)	I
I_e (Table 1.5-2)	1
Site Class (11.4.3 ASCE 7-16)	D
S_s (https://hazards.atcouncil.org/#/seismic?lat=34.0728128&lng=-118.2907456&address=3554%20W%201st%20St%2C%20Los%20Angeles%2C%20CA%2090004%2C%20USA)	2.022
S_1 (https://hazards.atcouncil.org/#/seismic?lat=34.0728128&lng=-118.2907456&address=3554%20W%201st%20St%2C%20Los%20Angeles%2C%20CA%2090004%2C%20USA)	0.721
F_a (11.4.4 and Table 11.4-1 ASCE 7-16)	1.2
F_v (Table 11.4-2 ASCE 7-16)	1.7
S_{ms} (Equation 11.4-1 ASCE 7-16)	2.426
S_{m1} (Equation 11.4-2 ASCE 7-16)	1.226
S_{DS} (Equation 11.4-3 ASCE 7-16)	1.618
S_{D1} (Equation 11.4-4 ASCE 7-16)	0.817
T_L (s) (https://hazards.atcouncil.org/#/seismic?lat=34.0728128&lng=-118.2907456&address=3554%20W%201st%20St%2C%20Los%20Angeles%2C%20CA%2090004%2C%20USA)	8
SDC (Tables 11.6-1 and 11.6-2 ASCE 7-16)	D

1200-Gallon Cistern Dimensions	
Diameter (in)	76
Height (in)	66

1200-Gallon Cistern Seismic Weight	
Empty Weight (lb)	217
Volume (gal)	1200
Full Weight (lb)	10227.00033

Seismic Force of 1200-Gallon Cistern	
SDC (Section 13.1.2 ASCE 7-16)	D
Ip (Section 13.1.3 ASCE 7-16)	1
Rp (Table 13.6-1 ASCE 7-16)	1.5
ap (Table 13.6-1 ASCE 7-16)	1
Overstrength Factor (Table 13.6-1 ASCE 7-16)	2
z/h	1
Fp (lb) (Equation 13.3-1 ASCE 7-16)	13237.83
Fp (lb) (Equation 13.3-2 ASCE 7-16)	26475.66
Fp (lb) (Equation 13.3-3 ASCE 7-16)	4964.19

Fp Governing (lb)	13237.83
Fv (lb) (Section 13.3.1.2 ASCE 7-16)	3309.46
Height to Center of Gravity Full (ft)	2.75
*Overturning Moment (lb*ft)*	36404.03
Distance Between Anchors (ft)	4.48
Tension (lb)	8128.91

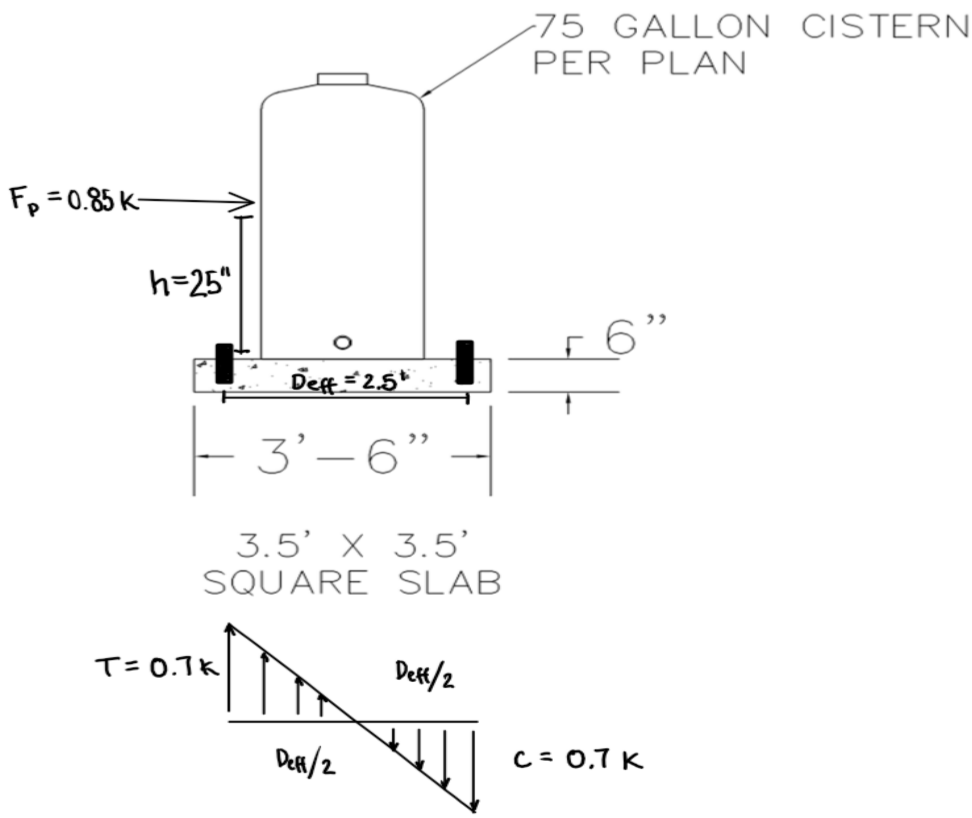


75-Gallon Rain Barrel Dimensions	
Diameter (in)	23
Height (in)	50

75-Gallon Rain Barrel Seismic Weight	
Empty Weight (lb)	30
Volume (gal)	75
Full Weight (lb)	655.6250208

Seismic Force of 75-Gallon Rain Barrel	
SDC (Section 13.1.2 ASCE 7-16)	D
Ip (Section 13.1.3 ASCE 7-16)	1
Rp (Table 13.6-1 ASCE 7-16)	1.5

ap (Table 13.6-1 ASCE 7-16)	1
Overstrength Factor (Table 13.6-1 ASCE 7-16)	2
z/h	1
Fp Garden Education Center Cistern (lb) (Equation 13.3-1 ASCE 7-16)	848.64
Fp Garden Education Center Cistern (lb) (Equation 13.3-2 ASCE 7-16)	1697.28
Fp Garden Education Center Cistern (lb) (Equation 13.3-3 ASCE 7-16)	318.24
Fp Garden Education Center Cistern Governing (lb)	848.64
Garden Education Center Cistern Fv (lb) (Section 13.3.1.2 ASCE 7-16)	212.16
Height to Center of Gravity Full (ft)	2.08
*Overturning Moment (lb*ft)*	1768.00
Distance Between Anchors (ft)	2.50
Tension (lb)	707.20



RAINWATER COLLECTION - 1200 GALLON TANK FOUNDATION DESIGN

Minimum Slab Area Based on Anchorage	
Plate Diameter (in)	80
Diameter with added foot (in)	92
Square Slab Dimensions (ft)	7.67
Rounded Slab Dimensions (ft)	7.75
Slab Depth (ft)	0.5

Soil Properties		
Soil Classification	SM	
N	23.3	blows
moist unit weight	120.0	pcf
c	0.0	psf
approx. friction angle'	39.0	degrees

Bearing Capacity Calculations		
Bearing Capacity Calcs - Terzaghi		
a	5.1	
Nq	70.2	
Nc	85.6	
Ny	198.8	
Kpy	298.0	
shape	sc	sy
strip	1	1
round	1.3	0.6
square	**1.3**	**0.8**
B	7.75	ft
L	7.75	ft
D	0.5	ft
q_bar	60.0	psf
q_ult	**78170.2**	**psf**
q_actual	170.3	psf
q_allow	26056.7	psf
F.S.	3	
Acceptable?	Yes	
Bearing Capacity Calcs - Meyerhoff		
Nq	55.6	
Nc	67.6	
Ny	76.7	
2tan(friction angle)(1-sin(friction angle))^2	0.2	
Kp	4.4	

sc	1.9	
sq	1.4	
sy	1.4	
dc	1.0	
dq	1.0	
dy	1.0	
q_ult	**56864.9**	**psf**
q_actual	170.3	psf
q_allow	18955.0	psf
F.S.	3.0	
Acceptable?	Yes	
Immediate Settlement Calcs		
B	7.8	ft
B'	3.9	ft
L	7.8	ft
L'	3.9	ft
M	1.0	
H	38.8	
N	10.0	
I1	0.5	
I2	0.0	
u	0.3	
d_borings	27.0	
o'v	3240.0	
CN	0.8	
N60	23.3	
CE	1.1	
N55	25.5	
Es	12945.5	
	9436.4	
	11190.9	kPa
Is	0.5	
L/B	1.0	
D/B	0.1	
If	0.8	
m	4.0	
qo	170.3	psf
delta_H	**0.089**	**in**
Acceptable?	Yes	

RAINWATER COLLECTION - 75 GALLON TANK FOUNDATION DESIGN

Minimum Slab Area Based on Anchorage	
Plate Diameter (in)	30
Diameter with added foot (in)	42
Square Slab Dimensions (ft)	3.5
Rounded Slab Dimensions (ft)	3.5
Slab Depth (ft)	0.5

Soil Properties		
Classification	SM	
N	23.3	blows
moist unit weight	120	pcf
c	0	psf
approx. friction angle'	39.0	degrees

Bearing Capacity Calculations		
Bearing Capacity Calcs - Terzaghi		
a	5.1	
Nq	70.2	
Nc	85.6	
Ny	198.8	
Kpy	298.0	
shape	sc	sy
strip	1	1
round	1.3	0.6
square	**1.3**	**0.8**
B	3.5	ft
L	3.5	ft
D	0.5	ft
q_bar	60	psf
q_ult	**37612.0**	**psf**
q_actual	53.5	psf
q_allow	12537.3	psf
F.S.	3	
Acceptable?	Yes	
Bearing Capacity Calcs - Meyerhoff		
Nq	55.6	
Nc	67.6	
Ny	76.7	
2tan(friction angle)(1-sin(friction angle))^2	0.2	
Kp	4.4	

sc	1.9	
sq	1.4	
sy	1.4	
dc	1.1	
dq	1.0	
dy	1.0	
q_ult	**28808.6**	**psf**
q_actual	53.5	psf
q_allow	9602.9	psf
F.S.	3.0	
Acceptable?	Yes	
Immediate Settlement Calcs		
B	3.5	ft
B'	1.8	ft
L	3.5	ft
L'	1.8	ft
M	1.0	
H	17.5	
N	10.0	
I1	0.5	
I2	0.0	
u	0.3	
d_borings	27.0	
o'v	3240.0	
CN	0.8	
N60	23.3	
CE	1.1	
N55	25.5	
Es	12945.5	
	9436.4	
	11190.9	kPa
Is	0.5	
L/B	1.0	
D/B	0.1	
If	0.8	
m	4.0	
qo	53.5	psf
delta_H	**0.013**	**in**
Acceptable?	Yes	

APPENDIX A-3

AQUAPONICS SYSTEM STRUCTURAL CALCULATIONS

AQUAPONICS - FRAMING DESIGN

Structural Frame Material Details

Member Name	Quantity	Nominal Dimensions Selected (ft)	Height (ft)	Material
Tall Edge Columns	2	4 by 4	8	No. 1 Douglas Fir Larch
Tall Interior Columns	2	4 by 4	8	No. 1 Douglas Fir Larch
Short Edge Columns	2	4 by 4	0.5	No. 1 Douglas Fir Larch
Short Interior Columns	2	4 by 4	0.5	No. 1 Douglas Fir Larch
Media Bed 1 Edge Beams	2	2 by 6	3	No. 1 Douglas Fir Larch
Media Bed 1 Interior Beams	2	2 by 6	3	No. 1 Douglas Fir Larch
Media Bed 1 Girders	1	2 by 10	6	No. 1 Douglas Fir Larch
Media Bed 2 Edge Beams	2	2 by 6	3	No. 1 Douglas Fir Larch
Media Bed 2 Interior Beams	2	2 by 6	3	No. 1 Douglas Fir Larch
Media Bed 2 Girders	1	2 by 10	6	No. 1 Douglas Fir Larch
Media Bed 3 Edge Beams	2	2 by 6	3	No. 1 Douglas Fir Larch
Media Bed 3 Interior Beams	2	2 by 6	3	No. 1 Douglas Fir Larch
Media Bed 3 Girders	1	2 by 10	6	No. 1 Douglas Fir Larch
Fish Tank Girders	2	2 by 10	6	No. 1 Douglas Fir Larch
Fish Tank Edge Beams	2	2 by 6	3	No. 1 Douglas Fir Larch
Fish Tank Interior Beams	2	2 by 6	3	No. 1 Douglas Fir Larch

Media Bed Beam Sizing

Member Name	Dimensions Required (ft)	Quantity	Nominal Dimensions Selected (ft)	Length (in)	Width (in)	Height (ft)
Media Bed 1 Edge Beams	3 ft long	2	2 by 6	5.5	1.5	3
Media Bed 1 Interior Beams	3 ft long	2	2 by 6	5.5	1.5	3
Media Bed 2 Edge Beams	3 ft long	2	2 by 6	5.5	1.5	3
Media Bed 2 Interior Beams	3 ft long	2	2 by 6	5.5	1.5	3
Media Bed 3 Edge Beams	3 ft long	2	2 by 6	5.5	1.5	3
Media Bed 3 Interior Beams	3 ft long	2	2 by 6	5.5	1.5	3

Fish Tank Beam Sizing

Member Name	Dimensions Required (ft)	Quantity	Nominal Dimensions Selected (ft)	Length (in)	Width (in)	Height (ft)
Fish Tank Edge Beams	3 ft long	2	2 by 6	5.5	1.5	3
Fish Tank Interior Beams	3 ft long	2	2 by 6	5.5	1.5	3

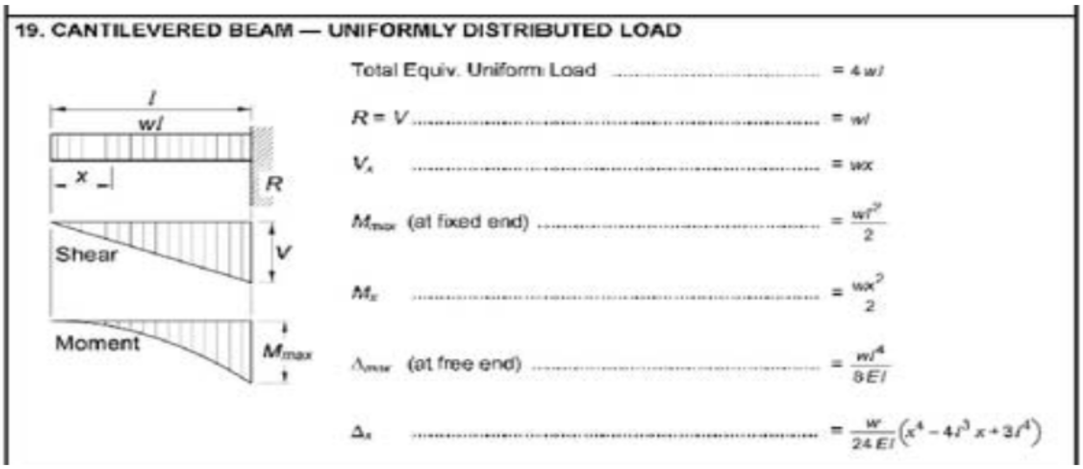
No. 1 Douglas Fir Larch Design Parameters	
Fb (NDS Table 4A) (psi)	1000
Ft (NDS Table 4A) (psi)	675
Fv (NDS Table 4A) (psi)	180

INCLUDE STRUCTURAL SHEATHING

72 ft^2

Plywood Structural Sheathing Panel
strucutral 10.375 in thickness

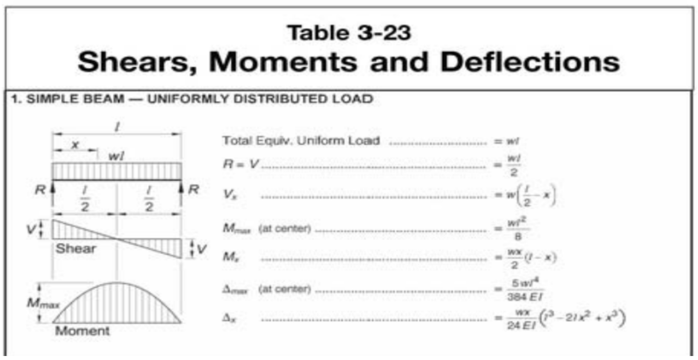
CHECK BEARING AT ALL CONNECTIONS



Material	Moment of Inertia (in^4) (NDS)	Section Modulus (in^3) (NDS)	E (psi) (NDS)	Spacing (in)	Tributary Width (in)	Tributary Width (ft)	Tributary Area (in^2)
No. 1 Douglas Fir Larch	20.8	7.563	2E+06	24	12	1	432
No. 1 Douglas Fir Larch	20.8	7.563	2E+06	24	24	2	864
No. 1 Douglas Fir Larch	20.8	7.563	2E+06	24	12	1	432
No. 1 Douglas Fir Larch	20.8	7.563	2E+06	24	24	2	864
No. 1 Douglas Fir Larch	20.8	7.563	2E+06	24	12	1	432
No. 1 Douglas Fir Larch	20.8	7.563	2E+06	24	24	2	864

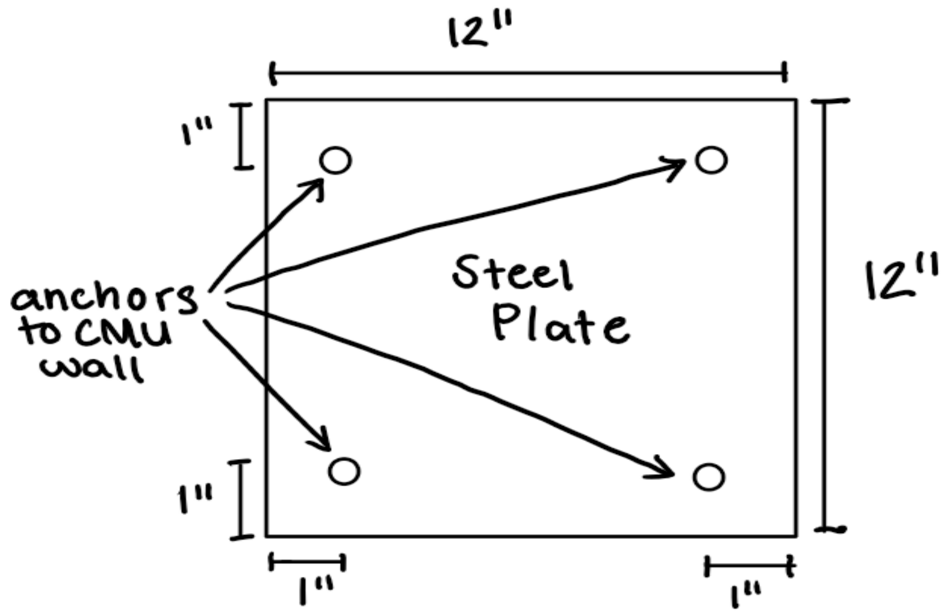
Material	Moment of Inertia (in^4) (NDS)	Section Modulus (in^3) (NDS)	E (psi) (NDS)	Spacing (in)	Tributary Width (in)	Tributary Width (ft)	Tributary Area (in^2)
No. 1 Douglas Fir Larch	20.8	7.146	2E+06	24	12	1	432
No. 1 Douglas Fir Larch	20.8	7.146	2E+06	24	24	2	864

Beam Gravity Bracing to CMU Wall	
Maximum Moment on Beam (lb*in)	9517.952
Anchor Type	HY 270 + threaded rod 5.8
Anchor Diameter (in)	3/8
Embedment Depth (in)	4
No. of Anchors per Plate	4
Steel Plate Size (in)	12 by 12
Steel Plate Thickness (in)	0.4



Tributary Area (ft^2)	Gravity Load Beams (psf)	Gravity Load on Beams (plf)	Beam Type	Beam Max Shear (lb)	Beam Max Moment (lb*ft)	Beam Max Deflection (in)
3	36.43733333	36.43733333	Cantilever	109.312	163.968	0.018029061
6	36.43733333	72.87466667	Cantilever	218.624	327.936	0.036058121
3	36.43733333	36.43733333	Cantilever	109.312	163.968	0.018029061
6	36.43733333	72.87466667	Cantilever	218.624	327.936	0.036058121
3	88.12918519	88.12918519	Cantilever	264.3875556	396.5813333	0.043606002
6	88.12918519	176.2583704	Cantilever	528.7751111	793.1626667	0.087212004

Tributary Area (ft^2)	Gravity Load Beams (psf)	Gravity Load on Beams (plf)	Beam Type	Beam Max Shear (lb)	Beam Max Moment (lb*ft)	Beam Max Deflection (in)
3	179.3866667	179.3866667	mply Support	269.08	201.81	0.00924582
6	179.3866667	358.7733333	mply Support	538.16	403.62	0.01849164



Max Bending Stress (psi)	Bending Design Value Fbn' (psi)	Bending Acceptable?	Shear Design Value Fvn' (psi)	Shear Acceptable?	Allowable Deflection (in)	Deflection Acceptable?
260.1634272	1883.284291	Yes	233.28	Yes	0.1	Yes
520.3268544	1883.284291	Yes	233.28	Yes	0.1	Yes
260.1634272	1883.284291	Yes	233.28	Yes	0.1	Yes
520.3268544	1883.284291	Yes	233.28	Yes	0.1	Yes
629.2444797	1883.284291	Yes	233.28	Yes	0.1	Yes
1258.488959	1883.284291	Yes	233.28	Yes	0.1	Yes

Max Bending Stress (psi)	Bending Design Value Fbn' (psi)	Bending Acceptable?	Shear Design Value Fvn' (psi)	Shear Acceptable?	Allowable Deflection (in)	Deflection Acceptable?
338.8916877	1893.048983	Yes	233.28	Yes	0.1	Yes
677.7833753	1893.048983	Yes	233.28	Yes	0.1	Yes

Fc1 (NDS Table 4A) (psi)	625	
Fc (NDS Table 4A) (psi)	1500	f

2 by 6 Beam Design Parameters For Bending	
Cf (NDS Table 4A)	1.30
FbCf	1300.00
Cm (NDS Table 4A)	0.85
Cfu (NDS Table 4A)	1.15
Cc (Design of Wood Structures 7th ed. Ch. 6)	1.00
Cl (Design of Wood Structures 7th ed. Ch. 6)	1.00
Kf (Design of Wood Structures 7th ed. Ch. 6)	2.54
Bending Resistance Factor (Design of Wood Structures 7th	0.85
Fbn (Design of Wood Structures 7th ed. Ch. 6)	2540.00
Ct (Design of Wood Structures 7th ed. Ch. 4)	1.00
Cr (Design of Wood Structures 7th ed. Ch. 4)	1.15
Time Effect Factor (Design of Wood Structures 7th ed. Ch.	0.60
Ci (Design of Wood Structures 7th ed. Ch. 4)	1.00
CL Simply Supported	1.00
lu (in)	36.00
lu/d	6.55
le	47.88
RB	10.82
E' min n (psi) (Design of Wood Structures 7th ed. Ch. 6.3 -	1700000.00
FbEn	17429.94
Fbxn (Same as Fbn for sawn lumbar)	2540.00
Fbxn*	1646.13
CL Cantilever	0.99

2 by 6 Beam Design Parameters For Shear	
Shear Resistance Factor (Design of Wood Structures 7th ed. Ch. 6)	0.75
Kf (Design of Wood Structures 7th ed. Ch. 6)	2.88
Fvn	518.4
Time Effect Factor (Design of Wood Structures 7th ed. Ch. 4)	0.6
Cm (NDS Table 4A)	1
Ct (Design of Wood Structures 7th ed. Ch. 4)	1
Ci (Design of Wood Structures 7th ed. Ch. 4)	1
Cvr (Design of Wood Structures 7th ed. Ch. 6)	1

Girder Sizing

Member Name	Dimensions Required (ft)	Quantity	Nominal Dimensions Selected (ft)	Length (in)	Width (in)	Height (ft)
Media Bed 1 Girders	6 ft long	1	2 by 8	7.25	1.5	6
Media Bed 2 Girders	6 ft long	1	2 by 8	7.25	1.5	6
Media Bed 3 Girders	6 ft long	1	2 by 8	7.25	1.5	6
Fish Tank Girders	6 ft long	2	2 by 8	7.25	1.5	6

Material	Moment of Inertia (in^4) (NDS)	Section Modulus (in^3) (NDS)	E (psi) (NDS)	Spacing (in)	Tributary Width (in)	Tributary Width (ft)	Tributary Area (in^2)
No. 1 Douglas Fir Larch	47.63	13.14	2E+06	36	36	3	2592
No. 1 Douglas Fir Larch	47.63	13.14	2E+06	36	36	3	2592
No. 1 Douglas Fir Larch	47.63	13.14	2E+06	36	36	3	2592
No. 1 Douglas Fir Larch	47.63	13.14	2E+06	36	18	1.5	1296

Tributary Area (ft^2)	Gravity Load (psf)	Gravity Load (plf)	Member Type	Max Shear (lb)	Max Moment (lb*ft)	Max Deflection (in)
18	36.43733333	109.312	mply Support	327.936	491.904	0.039366414
18	36.43733333	109.312	mply Support	327.936	491.904	0.039366414
18	88.12918519	264.3875556	mply Support	793.1626667	1189.744	0.095213609
9	179.3866667	269.08	mply Support	807.24	1210.86	0.096903494

Max Bending Stress (psi)	Bending Design Value Fbn' (psi)	Bending Acceptable?	Shear Design Value Fvn' (psi)	Shear Acceptable?	Allowable Deflection (in)	Deflection Acceptable?
449.2273973	1519.5042	Yes	233.28	Yes	0.2	Yes
449.2273973	1519.5042	Yes	233.28	Yes	0.2	Yes
1086.524201	1519.5042	Yes	233.28	Yes	0.2	Yes
1105.808219	1519.5042	Yes	233.28	Yes	0.2	Yes

2 by 8 Girder Design Parameters For Bending	
Cf (NDS Table 4A)	1.2
FbCf	1200
Cm (NDS Table 4A)	0.85
Cfu (NDS Table 4A)	1.15
Cc (Design of Wood Structures 7th ed. Ch. 6)	1
Cl (Design of Wood Structures 7th ed. Ch. 6)	1
Kf (Design of Wood Structures 7th ed. Ch. 6)	2.54
Bending Resistance Factor (Design of Wood Structures 7th ed. Ch. 6)	0.85
Fbn (Design of Wood Structures 7th ed. Ch. 6)	2540
Ct (Design of Wood Structures 7th ed. Ch. 4)	1
Cr (Design of Wood Structures 7th ed. Ch. 4)	1
Time Effect Factor (Design of Wood Structures 7th ed. Ch. 4)	0.6
Ci (Design of Wood Structures 7th ed. Ch. 4)	1
CL Simply Supported	1

2 by 8 Girder Design Parameters For Shear	
Shear Resistance Factor (Design of Wood Structures 7th	0.75
Kf (Design of Wood Structures 7th ed. Ch. 6)	2.88
Fvn	518.4
Time Effect Factor (Design of Wood Structures 7th ed. Ch. 4)	0.6
Cm (NDS Table 4A)	1
Ct (Design of Wood Structures 7th ed. Ch. 4)	1
Ci (Design of Wood Structures 7th ed. Ch. 4)	1
Cvr (Design of Wood Structures 7th ed. Ch. 6)	1

Column Sizing

Member Name	Dimensions Required (ft)	Quantity	Nominal Dimensions Selected (ft)	Length (in)	Width (in)	Height (ft)
Tall Edge Columns	8 ft tall	2	4 by 4	3.5	3.5	8
Tall Interior Columns	8 ft tall	2	4 by 4	3.5	3.5	8
Short Edge Columns	0.5 ft tall	2	4 by 4	3.5	3.5	0.5
Short Interior Columns	0.5 ft tall	2	4 by 4	3.5	3.5	0.5

4 by 4 Column Design Parameters for Compression	
Kf (Design of Wood Structures 7th ed. Ch. 4)	2.4
Fcn (psi) (Design of Wood Structures 7th ed. Ch.6)	3600
Compression Resistance Factor (Design of Wood Structures	0.9
Time Effect Factor (Design of Wood Structures 7th ed. Ch.	0.6

Material	Moment of Inertia (in^4) (NDS)	Section Modulus (in^3) (NDS)	E (psi) (NDS)	Spacing (in)	Tributary Width (in)	Tributary Width (ft)	Tributary Area (in^2)
No. 1 Douglas Fir Larch	12.51	7.146	2E+06	24	12	1	1152
No. 1 Douglas Fir Larch	12.51	7.146	2E+06	24	24	2	2304
No. 1 Douglas Fir Larch	12.51	7.146	2E+06	24	12	1	72
No. 1 Douglas Fir Larch	12.51	7.146	2E+06	24	24	2	144

Tributary Area (ft^2)	Gravity Load on Connecting Girders (plf)	Gravity Load on Column (lb)	Member Type	Compressive Design Value Parallel to Grain with Buckling (psi)	Compression Parallel Acceptable?	Compressive Design Value Perpendiculat to Grain for Bearing (psi)
8	752.0915556	752.0915556	ned at both er	1572.505	Yes	
16	752.0915556	1504.183111	ned at both er	1572.505	Yes	
0.5	269.08	269.08	ned at both er	2332.8	Yes	
1	269.08	538.16	ned at both er	2332.8	Yes	

Cf (NDS Table 4A)	1.5
FcCf	2250
Cm (NDS Table 4A)	0.8
Ct (Design of Wood Structures 7th ed. Ch. 4)	1
Cp Short (Design of Wood Structures 7th ed. Ch. 6)	1
le/d Tall Columns	27.4285714
Kf Stability	1.76
Stability Resistance Factor	0.85
E min (psi)	1700000
E min n	2992000
E'min n	2034560
CT	1
c	0.8
FcEn	2222.98198
*Fcn**	2332.8
Cp Tall (Design of Wood Structures 7th ed. Ch. 6)	0.67408479
Ci (Design of Wood Structures 7th ed. Ch. 4)	1

AQUAPONICS - SEISMIC DESIGN

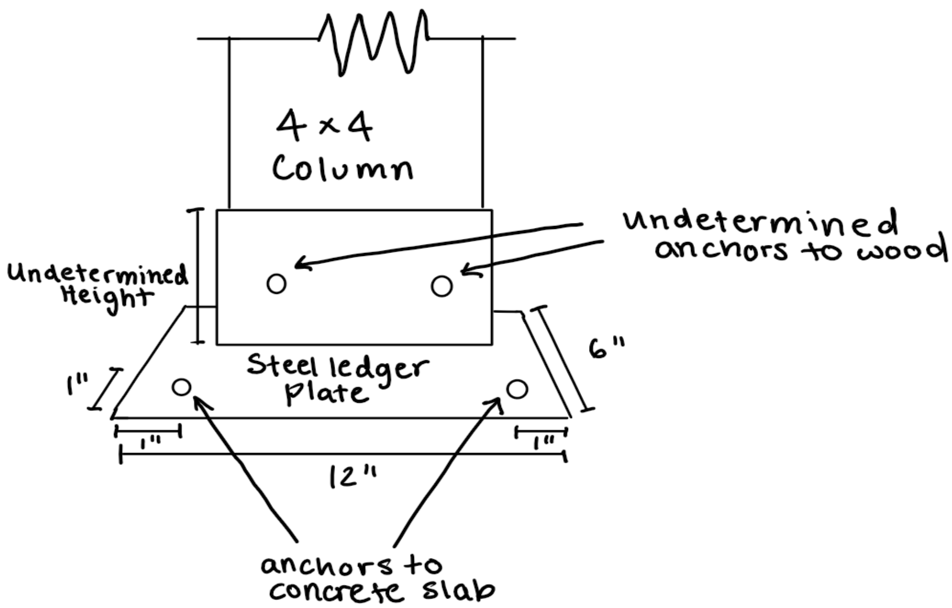
Seismic Design Parameters for Site	
Building Occupancy Risk Category Autoshop (Table 1.5-1 ASCE 7-16)	II
I_e (Table 1.5-2)	1
Site Class (11.4.3 ASCE 7-16)	D
S_s (https://hazards.atcouncil.org)	2.022
S_1 (https://hazards.atcouncil.org)	0.721
F_a (11.4.4 and Table 11.4-1 ASCE 7-16)	1.2
F_v (Table 11.4-2 ASCE 7-16)	1.7
S_{ms} (Equation 11.4-1 ASCE 7-16)	2.426
S_{m1} (Equation 11.4-2 ASCE 7-16)	1.226
S_{DS} (Equation 11.4-3 ASCE 7-16)	1.618
S_{D1} (Equation 11.4-4 ASCE 7-16)	0.817
T_L (s) (https://hazards.atcouncil.org)	8
SDC (Tables 11.6-1 and 11.6-2 ASCE 7-16)	D

Seismic Weight Calculation	
Fish Tank Weight (lb)	2306.4
Media Bed 1 Weight (lb)	468.48
Media Bed 2 Weight (lb)	468.48
Media Bed 3 Weight (lb)	1133.09
2 by 6 Weight (lb)	54
2 by 8 Weight (lb)	36
4 by 4 Weight (lb)	60.16
Conservative Wood Frame Weight (lb)	150.16
Wp (lb)	2220.21

esign of Non-Structural Component (Ch. 13 ASCE 7-16 for Aquaponics anchored to	
SDC (Section 13.1.2 ASCE 7-16)	D
Ip (Section 13.1.3 ASCE 7-16)	1
Rp (Table 13.5-1 ASCE 7-16)	2.5
ap (Table 13.5-1 ASCE 7-16)	1
Overstrength Factor (Table 13.5-1 ASCE 7-16)	2
z/h	0
Fp (lb) (Equation 13.3-1 ASCE 7-16)	574.7678
Fp (lb) (Equation 13.3-2 ASCE 7-16)	5747.678
Fp (lb) (Equation 13.3-3 ASCE 7-16)	1077.69
Governing Fp (lb)	1077.69
Fv (lb) (Section 13.3.1.2 ASCE 7-16)	718.4598
Height to center of mass	6
Overturning Moment (lb*ft)	6466.138

Overturning Moment (lb*in)	77593.66
Tension and Compresion Couple (lb)	1077.69
Tension Demand for Anchors Carrying Load in Both Directions (lb)	2155.379

Seismic Anchors on Columns to Concrete Slab	
Anchor Type	554 Gr.36)
Anchor Diameter (in)	1/2
Embedment Depth (in)	6.33
No. of Anchors Per Plate	2
Steel Ledger Plate Length (in)	12
Steel Plate Thickness (in)	1/2



AQUAPONICS - FOUNDATION DESIGN

Total Structure Weight	
Structural framing Density (pcf)	33.00
Beam Volume (cu ft)	2.75
Girder Volume (cu ft)	2.89
Column Volume (cu ft)	2.89
Structural Frame Weight (lb)	281.59
Structural Sheating Weight (psf)	0.40
Structural Sheathing Area (ft^2)	72.00
Structural Sheathing Weight (lb)	28.80
Media Bed 1 Weight (lb)	468.48
Media Bed 2 Weight (lb)	468.48
Media Bed 3 Weight (lb)	1133.09
Fish Tank Weight (lb)	2306.40
Total (lb):	4686.84

Soil Properties		
Classification	SM	
N	23.3	blows
moist unit weight	120.0	pcf
c	0.0	psf
approx. friction angle'	39.0	degrees

Bearing Capacity Calculations			
Bearing Capacity Calcs - Terzaghi			
a	5.1		
Nq	70.2		
Nc	85.6		
Ny	198.8		
Kpy	298.0		
shape	sc	sy	
strip	1		1
round	1.3		0.6
square	**1.3**		**0.8**
B	4.5	ft	
L	8	ft	
D	0.666666667	ft	
q_bar	80	psf	
q_ult	48558.8	psf	
q_actual	130.2	psf	
q_allow	16186.3	psf	
F.S.	3		
Acceptable?	Yes		

Bearing Capacity Calcs - Meyerhoff		
Nq	55.6	
Nc	67.6	
Ny	76.7	
2tan(friction angle)(1-sin(friction angle))^2	0.2	
Kp	4.4	
sc	1.5	
sq	1.2	
sy	1.2	
dc	1.1	
dq	1.0	
dy	1.0	
q_ult	**32337.3**	**psf**
q_actual	130.2	psf
q_allow	10779.1	psf
F.S.	3	
Acceptable?	Yes	
Immediate Settlement Calcs		
B	4.5	ft
B'	2.3	ft
L	8.0	ft
L'	4.0	ft
M	1.8	
H	22.5	
N	10.0	
I1	0.6	
I2	0.0	
u	0.3	
d_borings	27.0	
o'v	3240.0	
CN	0.8	
N60	23.3	
CE	1.1	
N55	25.5	
Es	12945.5	
	9436.4	
	11190.9	kPa
Is	0.6	
L/B	1.8	
D/B	0.1	
If	0.8	
m	4.0	
qo	130.2	psf
delta_H	**0.049**	**in**
Acceptable?	Yes	

APPENDIX B: Hilti PROFIS Seismic and Gravity Bracing

Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Apr 17, 2023	Date:	4/18/2023
Fastening point:			

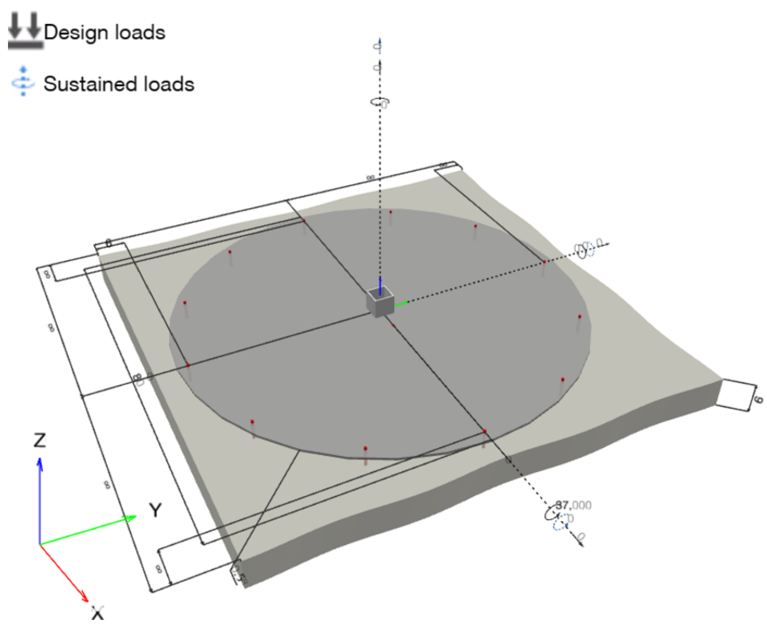
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HIT-Z 1/2**
Item number:	2018443 HIT-Z 1/2" x 4 1/2" (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Effective embedment depth:	$h_{ef,opti}$ = 2.907 in. ($h_{ef,limit}$ = 3.750 in.)
Material:	DIN EN ISO 4042
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2022 | 11/1/2024
Proof:	Design Method ACI 318-19 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate^R :	l_x x l_y x t = 80.000 in. x 80.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 6.000 in., Temp. short/long: 32/32 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar

^{R} - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



Company:		Page:	2
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Apr 17, 2023	Date:	4/18/2023
Fastening point:			

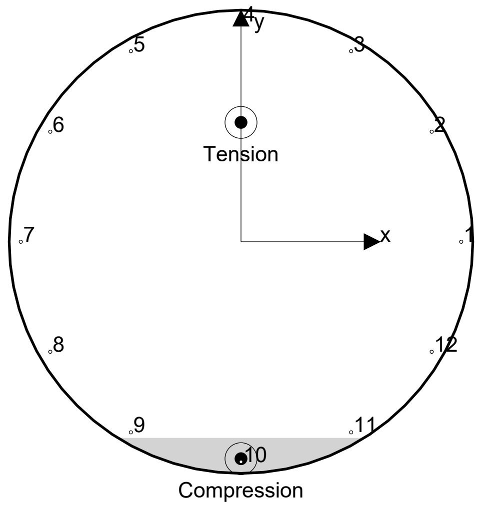
1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 0; V_x = 0; V_y = 0; M_x = 437,000; M_y = 0; M_z = 0;	no	98

2 Load case/Resulting anchor forces

Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	621	0	0	0
2	967	0	0	0
3	1,220	0	0	0
4	1,313	0	0	0
5	1,220	0	0	0
6	967	0	0	0
7	621	0	0	0
8	275	0	0	0
9	22	0	0	0
10	0	0	0	0
11	22	0	0	0
12	275	0	0	0



max. concrete compressive strain: 0.03 [‰]
max. concrete compressive stress: 114 [psi]
resulting tension force in (x/y)=(-0.000/20.613): 7,524 [lb]
resulting compression force in (x/y)=(-0.000/-37.467): 7,524 [lb]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	1,313	8,695	16	OK
Pullout Strength*	1,313	7,108	19	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	7,524	7,724	98	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value — refer to ICC-ES ESR-4868

$\phi\ N_{sa} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.14	94,200

Calculations

N_{sa} [lb]
13,377

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
13,377	0.650	8,695	1,313

3.2 Pullout Strength

$N_{pn} = N_p\ \lambda_a$ — refer to ICC-ES ESR-4868

$\phi\ N_{pn} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

Variables

λ_a	N_p [lb]
1.000	10,936

Calculations

N_{pn} [lb]
10,936

Results

N_{pn} [lb]	$\phi_{concrete}$	$\phi\ N_{pn}$ [lb]	N_{ua} [lb]
10,936	0.650	7,108	1,313

3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2.907	0.000	17.158	11.091	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
6.026	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
836.89	76.08	1.000	0.203	1.000	1.000	5,330

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
11,883	0.650	7,724	7,524

Company:		Page:	5
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Apr 17, 2023	Date:	4/18/2023
Fastening point:			

4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	N/A	N/A	N/A	N/A
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Bond Strength controls)*	N/A	N/A	N/A	N/A
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (relevant anchors)

5 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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Fastening point:			

6 Installation data

Profile: Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.

Hole diameter in the fixture (pre-setting) : d_f = 0.562 in.

Hole diameter in the fixture (through fastening) : d_f = 0.625 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HIT-Z 1/2

Item number: 2018443 HIT-Z 1/2" x 4 1/2" (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 354 in.lb

Hole diameter in the base material: 0.562 in.

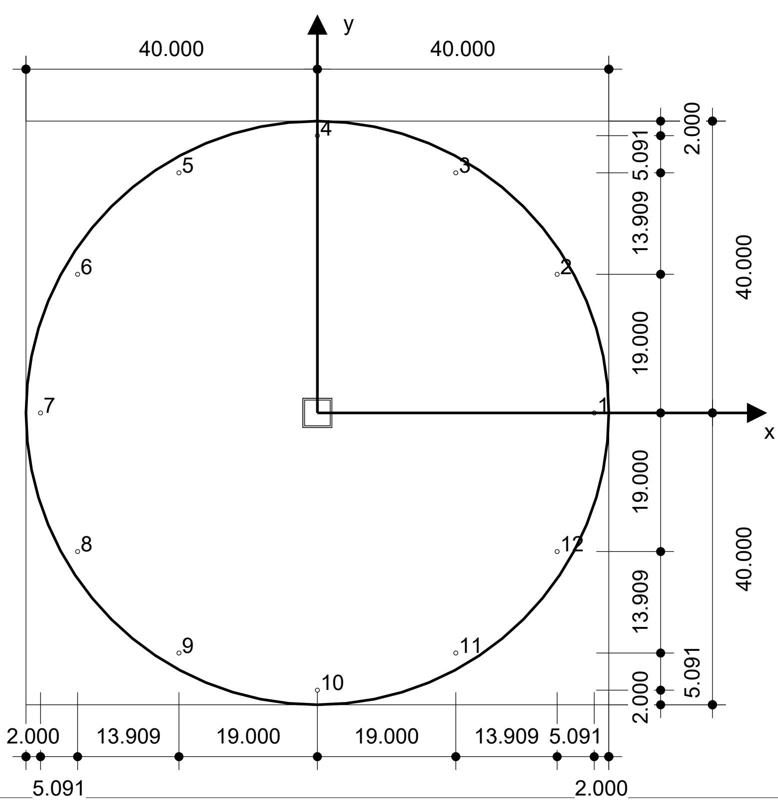
Hole depth in the base material: 3.907 in.

Minimum thickness of the base material: 5.157 in.

1/2 Hilti HIT-Z Carbon steel non-cleaning bonded expansion anchor with Hilti HIT-HY 200 V3 Safe Set System

6.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• -	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	38.000	-0.000	-	-	44.000	-
2	32.909	19.000	-	-	63.000	-
3	19.000	32.909	-	-	76.909	-
4	0.000	38.000	-	-	82.000	-
5	-19.000	32.909	-	-	76.909	-
6	-32.909	19.000	-	-	63.000	-
7	-38.000	-0.000	-	-	44.000	-
8	-32.909	-19.000	-	-	25.000	-
9	-19.000	-32.909	-	-	11.091	-
10	0.000	-38.000	-	-	6.000	-
11	19.000	-32.909	-	-	11.091	-
12	32.909	-19.000	-	-	25.000	-

7 Remarks; Your Cooperation Duties

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- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

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Fastening point:			

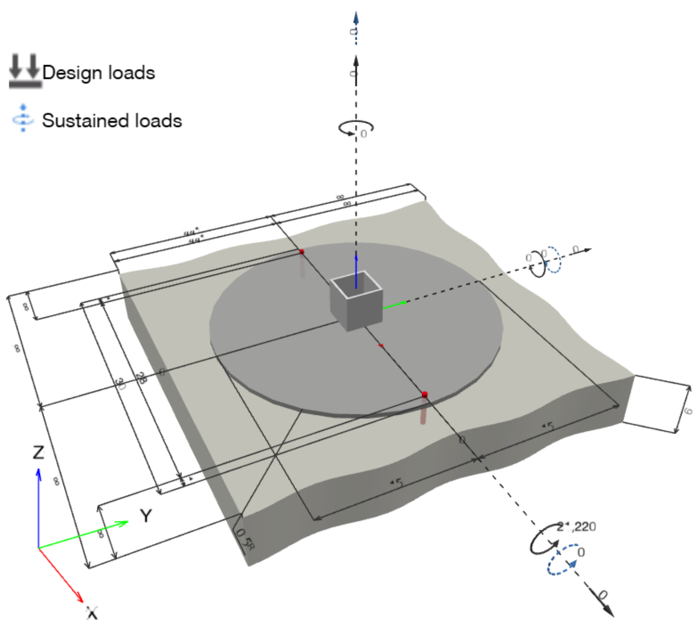
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HIT-Z 1/2**
Item number:	2018443 HIT-Z 1/2" x 4 1/2" (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Effective embedment depth:	$h_{ef,opti}$ = 2.750 in. ($h_{ef,limit}$ = 3.750 in.)
Material:	DIN EN ISO 4042
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2022 | 11/1/2024
Proof:	Design Method ACI 318-19 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate^R :	l_x x l_y x t = 30.000 in. x 30.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 6.000 in., Temp. short/long: 32/32 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar

^{R} - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



1.1 Design results

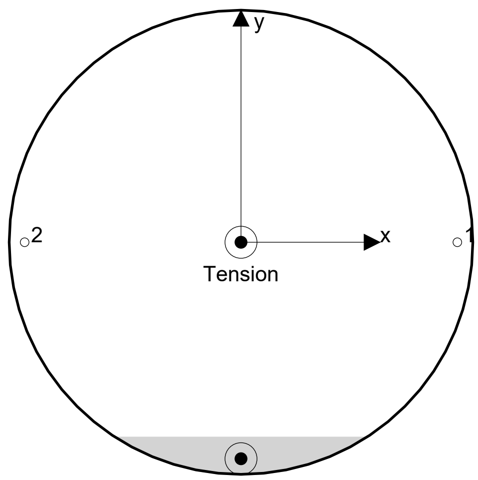
Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 0; V_x = 0; V_y = 0; M_x = 21,220; M_y = 0; M_z = 0;	no	24

2 Load case/Resulting anchor forces

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	758	0	0	0
2	758	0	0	0



max. concrete compressive strain: 0.03 [‰]
max. concrete compressive stress: 149 [psi]
resulting tension force in (x/y)=(-0.000/-0.000): 1,517 [lb]
resulting compression force in (x/y)=(0.000/-13.992): 1,517 [lb]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	758	8,695	9	OK
Pullout Strength*	758	7,108	11	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	1,517	6,374	24	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value — refer to ICC-ES ESR-4868

$\phi\ N_{sa} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.14	94,200

Calculations

N_{sa} [lb]
13,377

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
13,377	0.650	8,695	758

3.2 Pullout Strength

$N_{pn} = N_p\ \lambda_a$ — refer to ICC-ES ESR-4868

$\phi\ N_{pn} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

Variables

λ_a	N_p [lb]
1.000	10,936

Calculations

N_{pn} [lb]
10,936

Results

N_{pn} [lb]	$\phi_{concrete}$	$\phi\ N_{pn}$ [lb]	N_{ua} [lb]
10,936	0.650	7,108	758

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3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2.750	0.000	0.000	44.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
5.050	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
136.12	68.06	1.000	1.000	1.000	1.000	4,903

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
9,806	0.650	6,374	1,517

4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi\ V_n$	Status
Steel Strength*	N/A	N/A	N/A	N/A
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Bond Strength controls)*	N/A	N/A	N/A	N/A
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (relevant anchors)

5 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
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- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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Design:	Concrete - Apr 17, 2023	Date:	4/18/2023
Fastening point:			

6 Installation data

Profile: Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.

Hole diameter in the fixture (pre-setting) : d_f = 0.562 in.

Hole diameter in the fixture (through fastening) : d_f = 0.625 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HIT-Z 1/2

Item number: 2018443 HIT-Z 1/2" x 4 1/2" (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 354 in.lb

Hole diameter in the base material: 0.562 in.

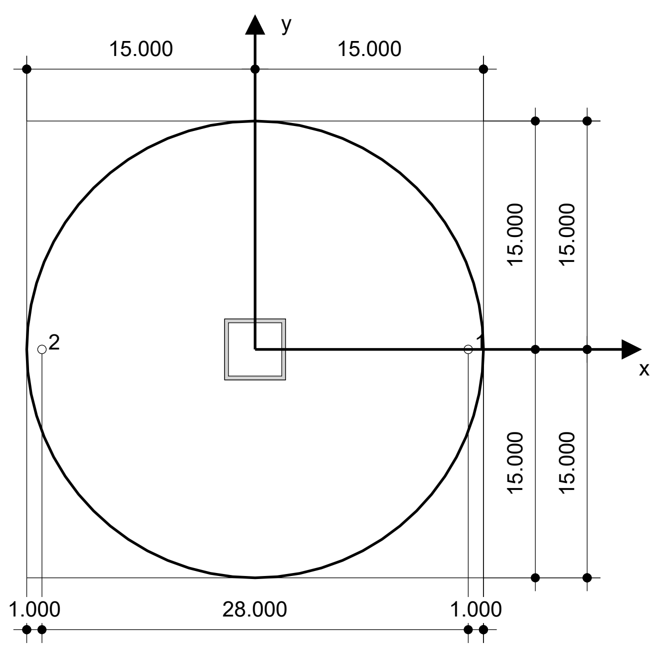
Hole depth in the base material: 3.750 in.

Minimum thickness of the base material: 5.000 in.

1/2 Hilti HIT-Z Carbon steel non-cleaning bonded expansion anchor with Hilti HIT-HY 200 V3 Safe Set System

6.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• -	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	14.000	0.000	-	-	44.000	-
2	-14.000	0.000	-	-	44.000	-

7 Remarks; Your Cooperation Duties

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- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

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Design:	Concrete - Apr 27, 2023	Date:	4/27/2023
Fastening point:			

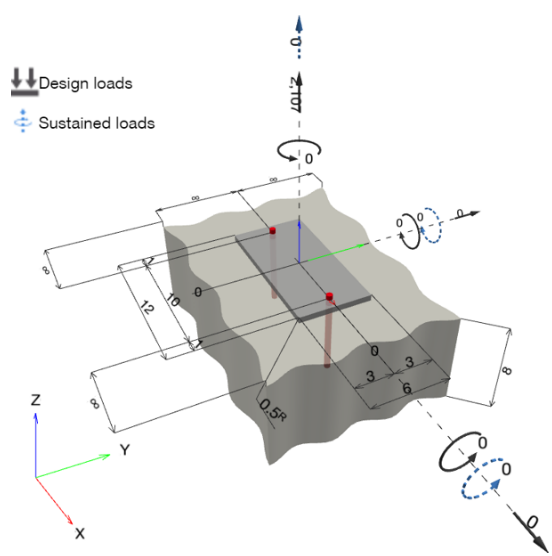
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HAS-V-36 (ASTM F1554 Gr.36) 1/2**
Item number:	2198023 HAS-V-36 1/2"x8" (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Effective embedment depth:	$h_{ef,opti}$ = 6.333 in. ($h_{ef,limit}$ = 6.750 in.)
Material:	ASTM F1554 Grade 36
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2022 | 11/1/2024
Proof:	Design Method ACI 318-19 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 12.000 in. x 6.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 8.000 in., Temp. short/long: 32/32 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.10.5.3 (a))
	Shear load: yes (17.10.6.3 (a))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



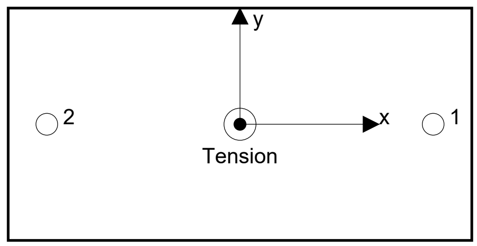
1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 2,107; V_x = 0; V_y = 0; M_x = 0; M_y = 0; M_z = 0;	yes	22

2 Load case/Resulting anchor forces

Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1,053	0	0	0
2	1,053	0	0	0



max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(-0.000/0.000): 2,107 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	1,053	6,172	18	OK
Bond Strength**	2,107	9,656	22	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	2,107	12,750	17	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value   refer to ICC-ES ESR-4868

$\phi\ N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.14	58,000

Calculations

N_{sa} [lb]
8,230

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
8,230	0.750	6,172	1,053

3.2 Bond Strength

$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ec1,Na}\ \psi_{ec2,Na}\ \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}$ ACI 318-19 Eq. (17.6.5.1b)

$\phi\ N_{ag} \geq N_{ua}$ ACI 318-19 Table 17.5.2

A_{Na} see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)

$A_{Na0} = (2\ c_{Na})^2$ ACI 318-19 Eq. (17.6.5.1.2a)

$c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ ACI 318-19 Eq. (17.6.5.1.2b)

$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e_N'}{c_{Na}}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.3.1)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.4.1b)

$\psi_{cp,Na} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.5.1b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \alpha_{N,seis} \cdot \pi \cdot d_a \cdot h_{ef}$ ACI 318-19 Eq. (17.6.5.2.1)

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,327	0.500	6.333	∞	1.000	1,190

$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	c_{ac} [in.]	λ_a	$\alpha_{N,seis}$
0.000	0.000	18.536	1.000	0.990

Calculations

c_{Na} [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$
7.239	354.41	209.62	1.000

$\psi_{ec1,Na}$	$\psi_{ec2,Na}$	$\psi_{cp,Na}$	N_{ba} [lb]
1.000	1.000	1.000	11,715

Results

N_{ag} [lb]	ϕ_{bond}	$\phi_{seismic}$	$\phi\ N_{ag}$ [lb]	N_{ua} [lb]
19,807	0.650	0.750	9,656	2,107

3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-19 Eq. (17.6.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.3.1)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
6.333	0.000	0.000	∞	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
18.536	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
550.91	360.93	1.000	1.000	1.000	1.000	17,134

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
26,153	0.650	0.750	12,750	2,107

4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	N/A	N/A	N/A	N/A
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Bond Strength controls)*	N/A	N/A	N/A	N/A
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (relevant anchors)

5 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0.
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

6 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.562 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-V-36 (ASTM F1554 Gr.36) 1/2

Item number: 2198023 HAS-V-36 1/2"x8" (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 360 in.lb

Hole diameter in the base material: 0.562 in.

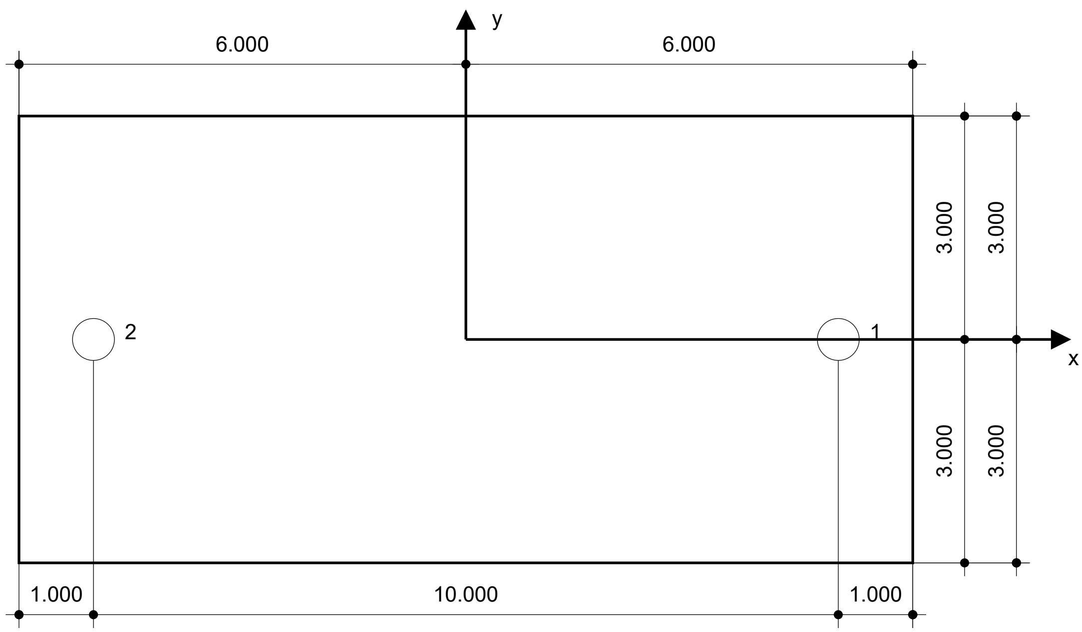
Hole depth in the base material: 6.333 in.

Minimum thickness of the base material: 7.583 in.

1/2 Hilti HAS Carbon steel threaded rod with Hilti HIT-HY 200 V3 Safe Set System

6.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	5.000	0.000	-	-	-	-
2	-5.000	0.000	-	-	-	-

7 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Masonry - Apr 27, 2023	Date:	4/27/2023
Fastening point:			

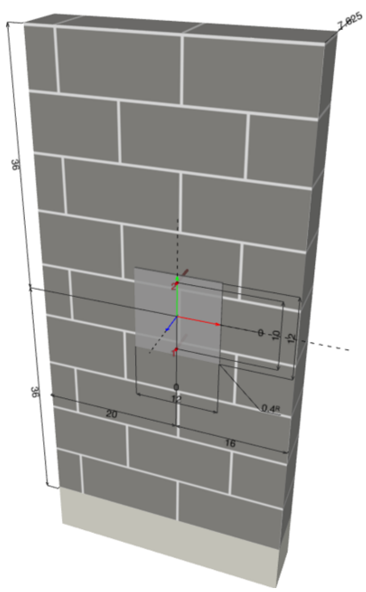
Specifier's comments:

1 Input data

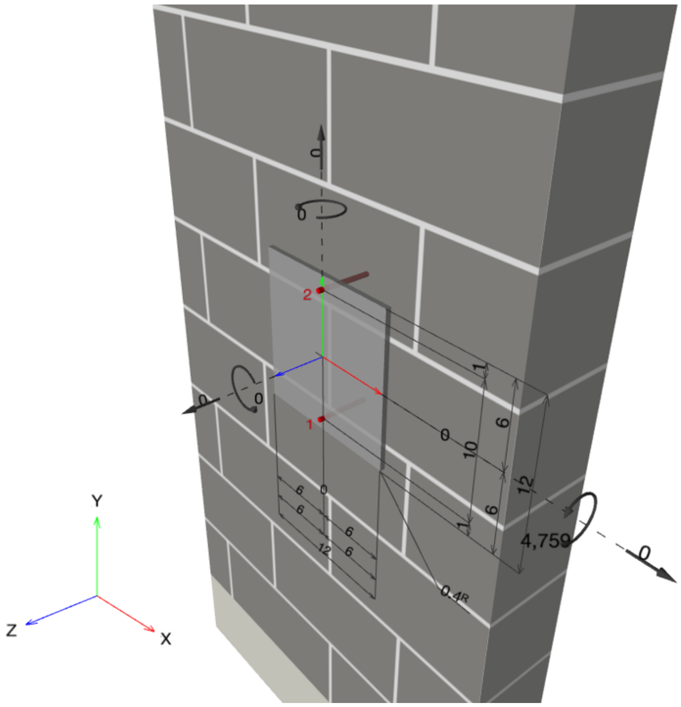
Anchor type and diameter:	**HY 270 + threaded rod 5.8 3/8**
Item number:	385418 HAS 5.8 3/8"x4-3/8" (element) / 2194247 HIT-HY 270 (adhesive)
Effective embedment depth:	h_{ef} = 3.375 in.
Material:	5.8
Evaluation Service Report:	ESR-4143
Issued I Valid:	3/1/2021 | 1/1/2022
Proof:	Design Method ASD Masonry
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.400 in.
Anchor plate[R] :	l_x x l_y x t = 12.000 in. x 12.000 in. x 0.400 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	Grout-filled CMU, L x W x H: 16.000 in. x 8.000 in. x 8.000 in.;
	Joints: vertical: 0.375 in.; horizontal: 0.375 in.
	Base material temperature: 68 °F
Installation:	Face installation
Seismic loads	no

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.]



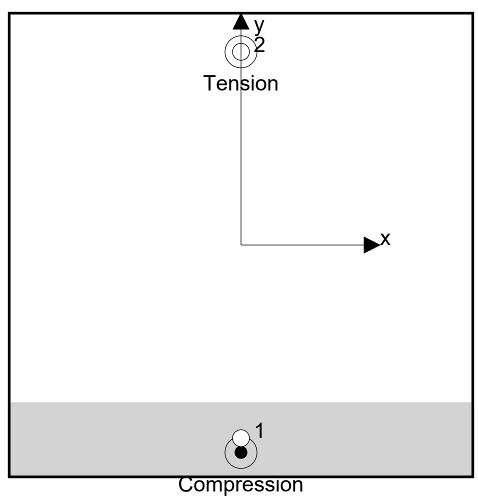
Geometry [in.] & Loading [lb, in.lb]



1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	$N = 0; V_x = 0; V_y = 0;$ $M_x = 4{,}759; M_y = 0; M_z = 0;$	no	38

2 Load case/Resulting anchor forces



Load case: Service loads

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0	0	0	0
2	459	0	0	0

max. compressive strain: 0.03 [‰]
max. compressive stress: 40 [psi]
resulting tension force in (x/y)=(0.000/5.000): 459 [lb]
resulting compression force in (x/y)=(0.000/-5.368): 459 [lb]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

Company:		Page:	3
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Masonry - Apr 27, 2023	Date:	4/27/2023
Fastening point:			

3 Tension load (Most utilized anchor 2)

	Load P_s [lb]	Capacity P_t [lb]	Utilization $\beta_P = P_s/P_t$ [%]	Status
Steel strength	459	2,640	18	OK
Bond strength	459	1,240	38	OK

3.1 Steel strength

$P_{t,s}$ = ESR Value refer to ICC-ES ESR-4143

$P_{t,s} \geq P_s$

Results

$P_{t,s}$ [lb]	P_s [lb]
2,640	459

3.2 Bond strength

$P_{t,b,Base}$ = ESR Value refer to ICC-ES ESR-4143

$P_{t,b} = P_{t,b,Base} \cdot f_{red,E} \cdot f_{red,s} \cdot f_{red,Temp} \cdot f_{red,Bedjoint}$

$P_{t,b} \geq P_s$

Variables

c_{min} [in.]	c_{cr} [in.]	s_{min} [in.]	s_{cr} [in.]	Temperature [°F]
4.000	12.000	4.000	13.500	68

Results

$P_{t,b}$ [lb]	$P_{t,b,Base}$ [lb]	P_s [lb]	$f_{red,E}$	$f_{red,S}$	$f_{red,Temp}$	$f_{red,Bedjoint}$
1,240	1,240	459	1.000	1.000	1.000	1.000

4 Shear load (Most utilized anchor 2)

	Load V_s [lb]	Capacity V_t [lb]	Utilization $\beta_V = V_s/V_t$ [%]	Status
Overall strength	N/A	N/A	N/A	N/A

5 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- The min. sizes of the bricks, the masonry compressive strength, the type / strength of the mortar and the grout (in case of fully grouted CMU walls) has to fulfill the requirements given in the relevant ESR-approval or in the PTG.
- Only the local load transfer from the anchor(s) to the wall is considered, a further load transfer in the wall is not covered by PROFIS!
- Wall is assumed as being perfectly aligned vertically – checking required(!): Noncompliance can lead to significantly different distribution of forces and higher tension loads than those calculated by PROFIS. Masonry wall must not have any damages (neither visible nor not visible)! While installation, the positioning of the anchors needs to be maintained as in the design phase i.e. either relative to the brick or relative to the mortar joints.
- The effect of the joints on the compressive stress distribution on the plate / bricks was not taken into consideration.
- If no significant resistance is felt over the entire depth of the hole when drilling (e.g. in unfilled butt joints), the anchor should not be set at this position or the area should be assessed and reinforced. Hilti recommends the anchoring in masonry always with sieve sleeve. Anchors can only be installed without sieve sleeves in solid bricks when it is guaranteed that it has not any hole or void.
- The accessories and installation remarks listed on this report are for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- The compliance with current standards (e.g. 2018, 2015, 2012, 2009 and 2006 IBC) is the responsibility of the user.
- Drilling method (hammer, rotary) to be in accordance with the approval!
- Masonry needs to be built in a regular way in accordance with state-of the art guidelines!
- Warnings/Notes - OST in Masonry HNA!

Fastening meets the design criteria!

Company:		Page:	5
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Masonry - Apr 27, 2023	Date:	4/27/2023
Fastening point:			

6 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.438 in.

Plate thickness (input): 0.400 in.

Drilling method: Drilled in hammer mode

Anchor type and diameter: HY 270 + threaded rod 5.8 3/8

Item number: 385418 HAS 5.8 3/8"x4-3/8" (element) / 2194247 HIT-HY 270 (adhesive)

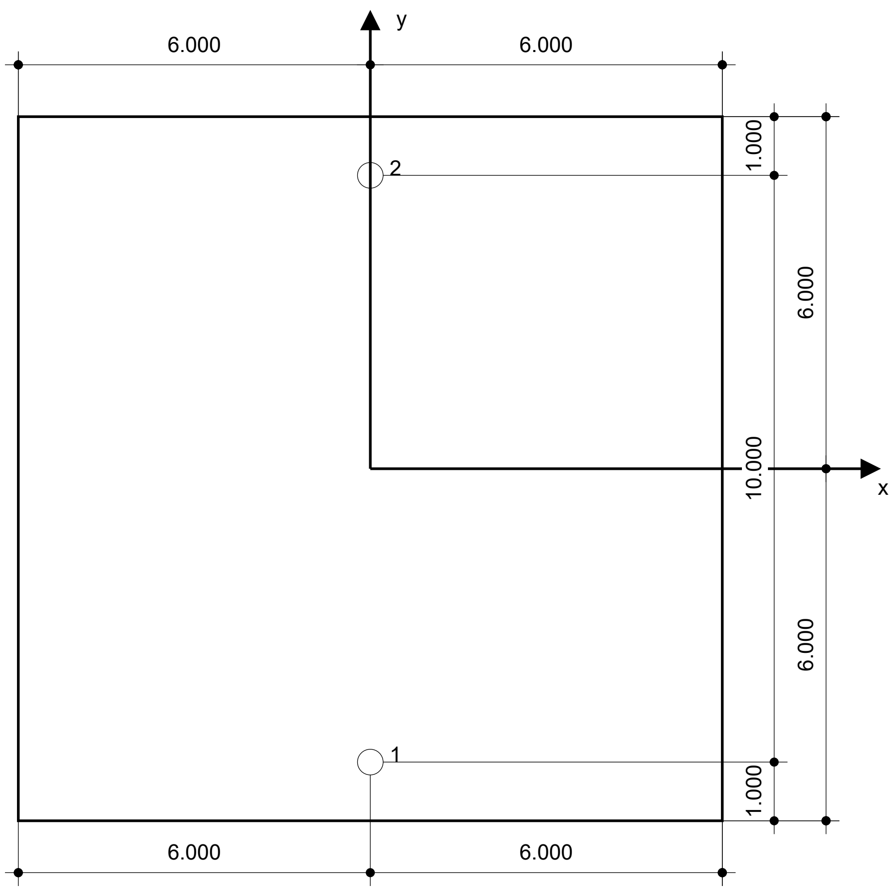
Maximum installation torque: 72 in.lb

Hole diameter in the base material: 0.438 in.

Hole depth in the base material: 3.375 in.

Minimum thickness of the base material: 7.625 in.

Hilti HIT-V threaded rod with HIT-HY 270 injection mortar with 3.375 in embedment h_ef, 3/8, Steel galvanized, Hammer drilled installation per ESR-4143



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	-5.000	20.000	16.000	31.000	41.000
2	0.000	5.000	20.000	16.000	41.000	31.000

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APPENDIX C: Runoff Calculations

SITE HYDROLOGY STUDY - RATIONAL METHOD

Rainfall Values	
rainfall intensity, I (in/hr)	0.04
24 hour 85th pctl	1
Site Area (ft^2)	10986.4
Impervious Percent (%)	19.8%

**24-hour 85th percentile*

Location	Area (ft^2)	Runoff Coefficient, C
Remediated Soil Area	8816.1	0.1
Songs Building Roof	2050.3	0.9
Shed Roof	120.0	1.00

Total Site Runoff

Location	*Q = C*i*A (ft^3/hr)*	*V, 24 hour (ft^3)*	*V, 24 hour (gal)*
Open Soil Space (SW)	3.1	73.5	549.5
Songs Building Roof	6.4	153.8	1150.2
Shed Roof	0.4	10.0	74.8
	Total Runoff (ft^3)	**237.2**	**1774.6**

Rainwater Collection Volume

Location	*Q = C*i*A (ft^3/hr)*	*V, 24 hour (ft^3)*	*V, 24 hour (gal)*
Songs Building Roof	6.4	153.8	1150.2
Shed Roof	0.4	10.0	74.8
	Design Volume (ft^3)	**163.8**	**1225.0**

	Cubic Feet (ft^3)	Gallons
Total Site Runoff	237.2	1774.6
Collection Design Volume	163.8	1225.0

	Cubic Feet per Second (cfs)	Gallons Per Minute (gpm)
Peak Flow Rate	0.0176	7.90

	Rainwater Collection Volume (gallons)	Tank Size (gallons)
Songs Building Roof	1087.9	1200
Shed Roof	72.8	75

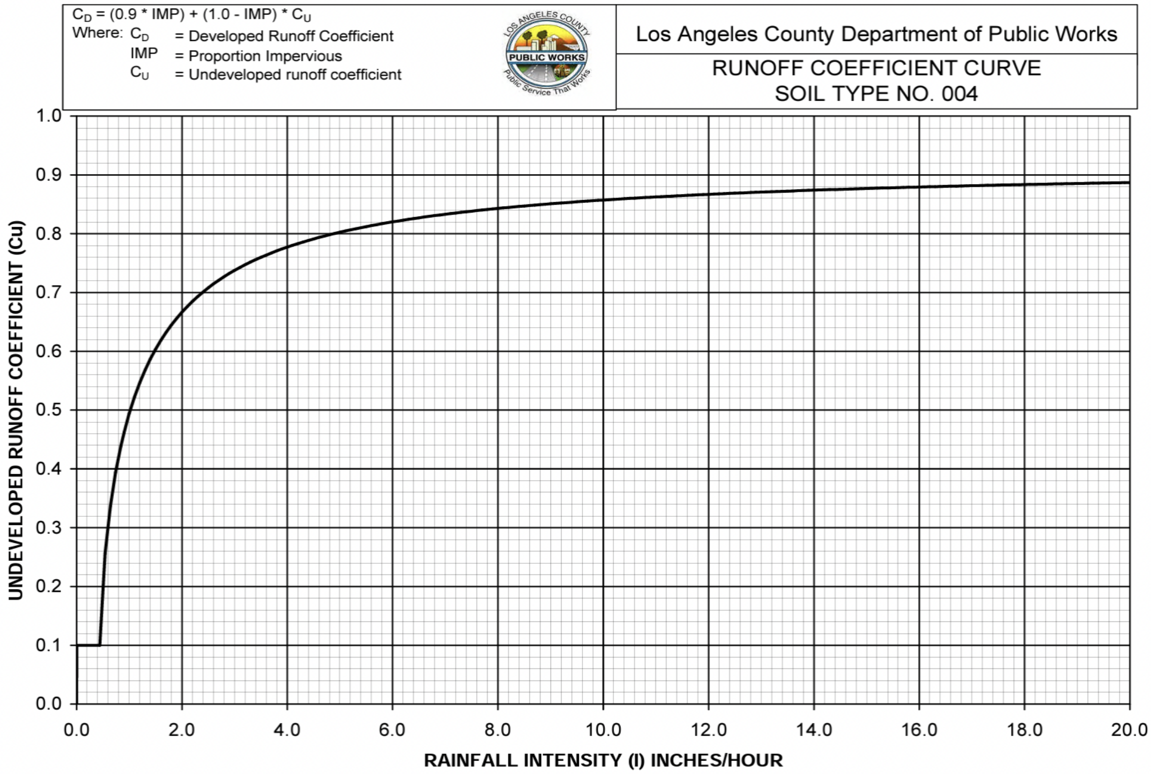


Table 3-2

Rational runoff coefficients (ASCE, 1975; Viessman, et al., 1996; and Malcom, 1999)

Description of Surface	Rational Runoff Coefficients, C
Unimproved Areas	0.35
Asphalt	0.95
Concrete	0.95
Brick	0.85
Roofs, inclined	1.00
Roofs, flat	0.90
Lawns, sandy soil, flat (<2%)	0.10
Lawns, sandy soil, average (2-7%)	0.15
Lawns, sandy soil, steep (>7%)	0.20
Lawns, heavy soil, flat (<2%)	0.15
Lawns, heavy soil, average (2-5%)	0.20
Lawns, heavy soil, steep (>7%)	0.30
Wooded areas	0.15

CAPTURE AND USE FEASIBILITY - ESTIMATED TOTAL WATER USE

Design Volume (ft^3)	163.8	**from hydrology study*
Pervious Area (acres)	0.20	
Planting Factor	0.30	**medium planting type*
ET_7	21.7	**for LA county*

(i) *Determine Design Volume in Gallons*

$$V_{design} = design\ volume\ in\ gallons \cdot \frac{7.48\ gal}{ft^3}$$

V_design (gal)	1225.0

(ii) *Determine Planting Area, PA*

$$PA = pervious\ acreage\ \cdot \frac{43560\ ft^2}{acre}$$

Planting Area (ft^2)	8816.1

(iii) *Determining Planter Factor, PF*

$$PF\ = planting\ factor \cdot PA$$

Planter Factor (ft^2)	2644.8

(iv) *Determine 7-month ETWU*

$$ETWU_7 = ET_7\ \cdot 0.62 \cdot PF$$

ETWU_7 (gal)	**35583.5**

APPENDIX D: Hydrology Report

Peak Flow Hydrologic Analysis

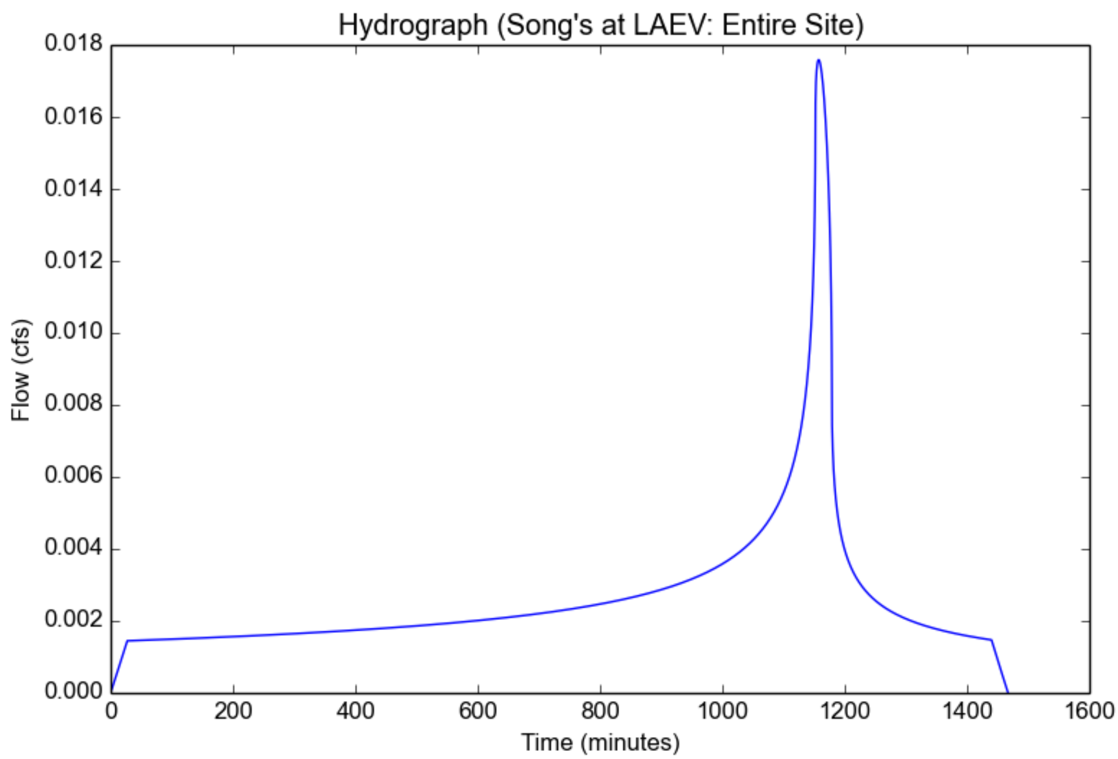
File location: C:/Users/jreichenberger/Desktop/Song's at LAEV - Entire Site.pdf
Version: HydroCalc 1.0.3

Input Parameters

Project Name	Song's at LAEV
Subarea ID	Entire Site
Area (ac)	0.252
Flow Path Length (ft)	185.0
Flow Path Slope (vft/hft)	0.016
85th Percentile Rainfall Depth (in)	1.0
Percent Impervious	0.198
Soil Type	4
Design Storm Frequency	85th percentile storm
Fire Factor	0
LID	True

Output Results

Modeled (85th percentile storm) Rainfall Depth (in)	1.0
Peak Intensity (in/hr)	0.2701
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.2584
Time of Concentration (min)	27.0
Clear Peak Flow Rate (cfs)	0.0176
Burned Peak Flow Rate (cfs)	0.0176
24-Hr Clear Runoff Volume (ac-ft)	0.0054
24-Hr Clear Runoff Volume (cu-ft)	234.4227



APPENDIX E: Aquaponics Calculations

AQUAPONICS CALCULATIONS

Tank Sizing	
Blue Tilapia wt (lbs)	4
Recommended (# fish)	20
gal/tilapia (1:3 ratio)	12
Tank Size (gal)	240
Media Bed Size (1-2) (gal)	25.2
Media Bed Size (top) (gal)	134.64

Fish Tank Dimensions	
Length (ft)	6
Width (ft)	3
Area (ft^2)	18
Depth (ft)	2
Volume (ft^3)	36
Volume (gal)	269.28

ledia Bed (1-2) Dimensions	
Length (ft)	6
Width (ft)	3
Area (ft^2)	18
Depth (ft)	0.375
Volume (ft^3)	6.75
Volume (gal)	50.49

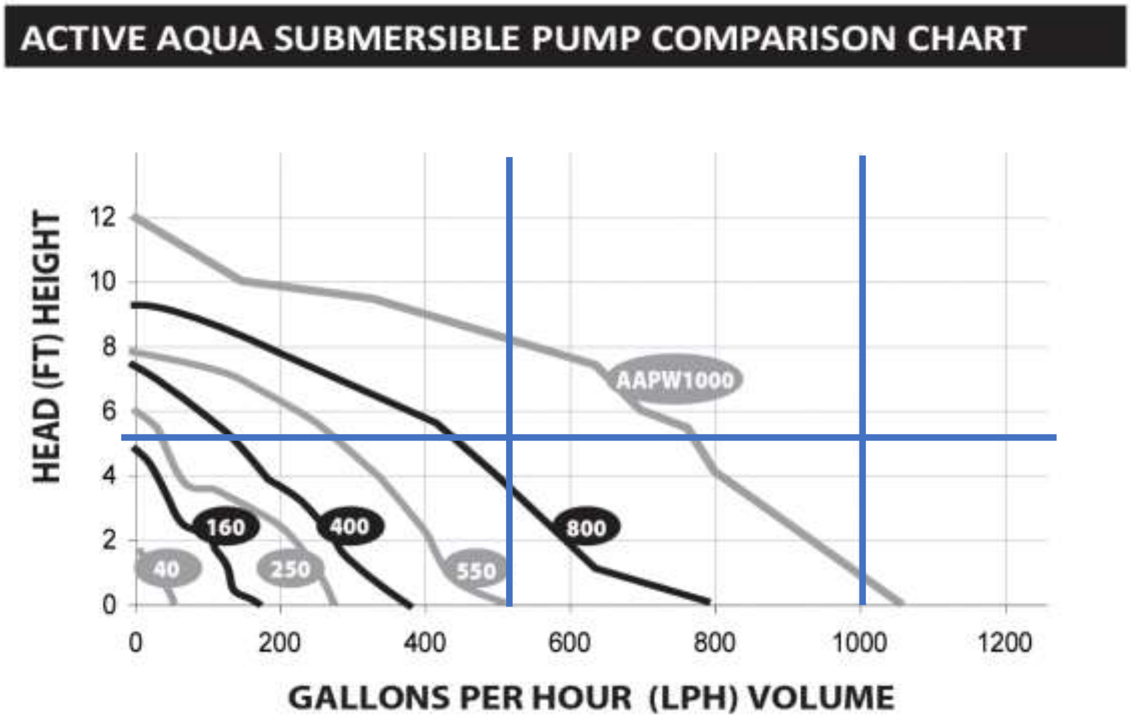
ledia Bed (top) Dimensions	
Length (ft)	6
Width (ft)	3
Area (ft^2)	18
Depth (ft)	1
Volume (ft^3)	18
Volume (gal)	134.64

System Height (ft)	
fish tank	2
fish tank - media bed 1	2
media bed 1	0.375
media bed 1 - media bed :	1
media bed 2	0.375
media bed 2 - media bed :	1
media bed 3	1
Total	7.75

Headloss (ft)	
Media Bed 1 (bottom)	2.375
Media Bed 2	3.75
Media Bed 3 (top)	5.75

Pump Sizing	
Fish Tank Vol (gal)	240.00
turnover (#/hr) *15min	4.00
Fish Tank max GPH	**960.00**
turnover (#/hr) *15min	2.00
Fish Tank min GPH	480.00
Media Bed (1-2) Vol (gal)	25.25
# media beds	2.00
40% water volume (gal)	20.20
Media Bed (top) Vol (gal)	134.64
40% water volume (gal)	53.86
Total Media Bed Vol (gal)	74.05
turnover (#/hr) *15min	4.00
Media Bed max GPH	296.21
turnover (#/hr) *15min	2.00
Media Bed min GPH	148.10

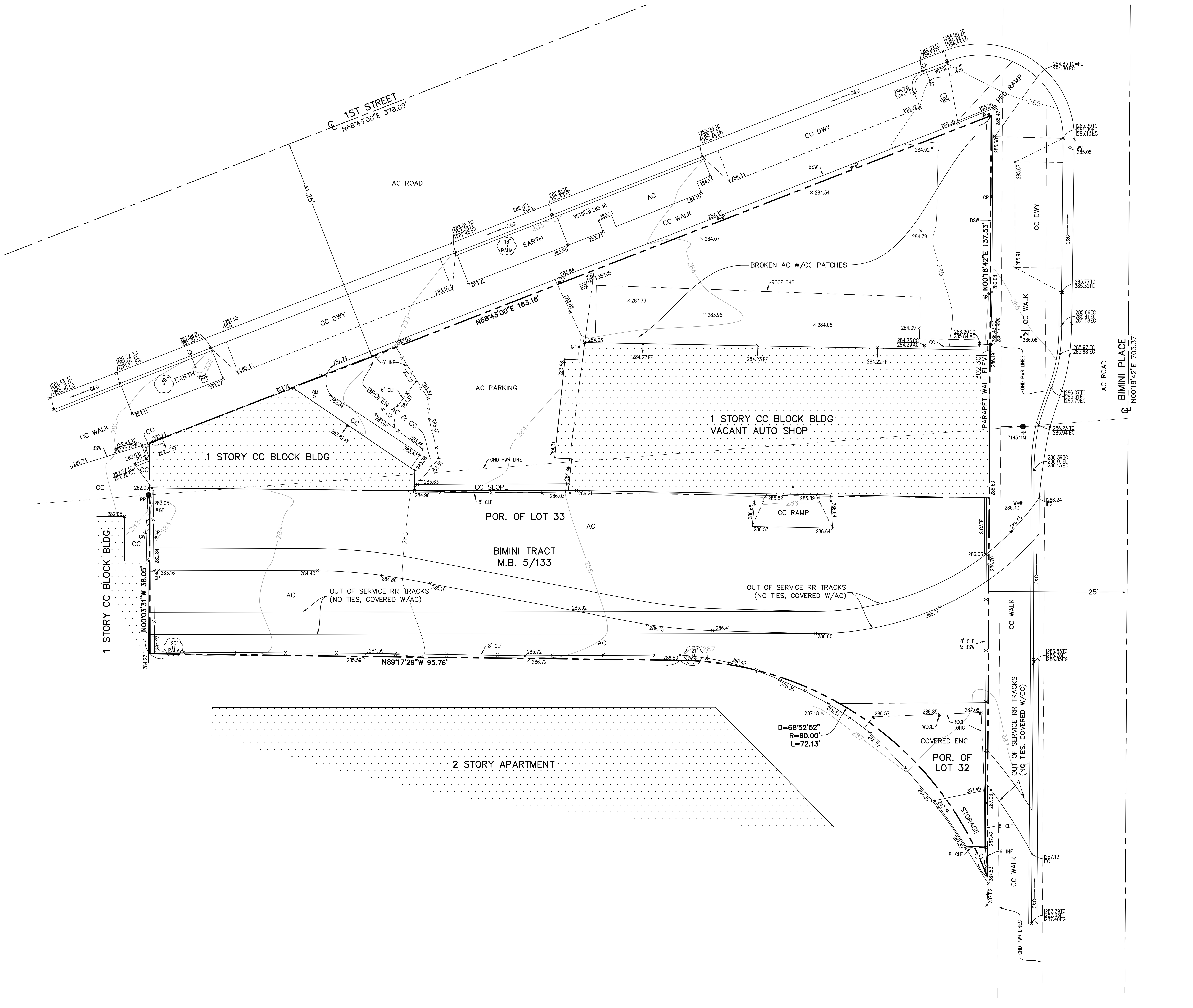
			Assume Gravity to Low Pressure. About 6f/s flow velocity, also suction side of pump		Assume Average Pressure. (20-100PSI) About 12f/s flow velocity	
Sch 40 Pipe Size	ID (range)	OD	**GPM** (with minimal pressure loss & noise)	**GPH** (with minimal pressure loss & noise)	**GPM** (with minimal pressure loss & noise)	**GPH** (with minimal pressure loss & noise)
1/2"	.50-.60"	.85"	7 gpm	420 gph	14 gpm	840 gph
3/4"	.75-.85"	1.06"	11 gpm	660 gph	23 gpm	1,410 gph
1"	1.00-1.03"	1.33"	16 gpm	960 gph	37 gpm	2,220 gph
1.25"	1.25-1.36"	1.67"	25 gpm	1,500 gph	62 gpm	3,750 gph
1.5"	1.50-1.60"	1.90"	35 gpm	2100 gph	81 gpm	4,830 gph
2"	1.95-2.05"	2.38"	55 gpm	3300 gph	127 gpm	7,650 gph
2.5"	2.35-2.45"	2.89"	80 gpm	4800 gph	190 gpm	11,400 gph
3"	2.90-3.05"	3.50"	140 gpm	8400 gph	273 gpm	16,350 gph
4"	3.85-3.95"	4.50"	240 gpm	14,400 gph	480 gpm	28,800 gph
5"	4.95-5.05"	5.563"	380 gpm	22,800 gph	750 gpm	45,000 gph
6"	5.85-5.95"	6.61"	550 gpm	33,000 gph	1100 gpm	66,000 gph
8"	7.96"	8.625"	950 gpm	57,000 gph	1900 gpm	114,000 gph



Hydrofarm Active Aqua Pump	
Pump Size	800-1000 GPH
Pipe Quality Checks	
Max Flow Rate (GPH)	1000.00
Max Flow Rate (ft^3/hr)	133.69
Max Flow Rate (ft^3/s)	0.04
Pipe Inner Diameter (ft)	0.08
Pipe Area (ft^2)	0.01
Velocity (ft/s)	6.81

Aeration Calculations	
Tank Volume (gal)	240.00
Fish Density (lb/gal) *1:3 ratio	0.33
Fish Consumption @ 1:1 FTE (lbs/day)	1.60
Fish Consumption @ 1:1 FTE (lbs/hr)	0.07
Fish Consumption @ 0.5:1 FTE (lbs/day)	0.80
Fish Consumption @ 0.5:1 FTE (lbs/hr)	0.03
*Oxygen Injection (lbs O2/time transferred) = CFM (ft3/min) of device * lbs of air/ft3 * lbs of oxygen/lb of air * (SOTE * Depth) * FTE * Time*	
*Diffuser *6" medium pore air stone (cfm)*	0.50
wt air	0.08
lbs O2/lbs air	0.23
SOTE	0.01
Depth	2.00
FTE	0.50
Time (min/hr)	60.00
Oxygen Injection (lbs O2/time transferred)	0.01
#air stones @ sea level *0:5:1 FTE @ 20% fish mass	6.44
LA elevation (ft)	305.00
#air stones @ site	6.52
min CFM required	3.50
safety factor	1.50
actual min CFM required	5.25
actual min L/hr required	8919.81

APPENDIX F: Topographic Survey



LEGEND

	CENTER LINE
	PROPERTY LINE
	CURB UNLESS OTHERWISE NOTED
	WALL
—X—X—	FENCE
⊠	COLUMN
	GUY WIRE
● PP	POWER POLE
•	GUARD POST
	STREET LIGHT
TS •	TRAFFIC SIGNAL
	SURFACE DRAIN
	FIRE HYDRANT
10"	TREE WITH TRUNK DIAMETER

ABBREVIATIONS

AC	ASPHALT CONCRETE
BLDG	BUILDING
BSW	BACK OF SIDEWALK
C&G	CURB & GUTTER
CB	CATCH BASIN
CC	CONCRETE
CLF	CHAIN LINK FENCE
DWY	DRIVEWAY
EG	EDGE OF GUTTER
ELEV	ELEVATION
ENC	ENCLOSURE
ER	EARTH
FF	FINISH FLOOR
FL	FLOW LINE
GM	GAS METER
GP	GUARD POST
GW	GUY WIRE
INF	IRON FENCE
M.B.	MAP BOOK
OHD	OVERHEAD
OHG	OVERHANG
PED	PEDESTRIAN
POR	PORTION
PP	POWER POLE
PWR	POWER
RF	ROOF
RR	RAILROAD
S.GATE	SLIDE GATE
TC	TOP OF CURB
TCB	TOP OF CATCH BASIN
TS	TRAFFIC SIGNAL
W/	WITH
WCOL	WOOD COLUMN
WM	WATER METER
WV	WATER VALVE
YBSL	YARD BOX STREET LIGHT
YBTS	YARD BOX TRAFFIC SIGNAL

NOTES

1. REFERENCE DOCUMENT FOR LEGAL DESCRIPTION AND EASEMENTS: CHICAGO TITLE COMPANY PRELIMINARY REPORT ESCROW NO. 58654-HH, DATED JUNE 23, 2016.

2. ASSESSOR'S PARCEL NUMBER: 5501-012-020.

3. LAND AREA: 10,986 SQ. FT. 0.252 ACRE

BRIEF LEGAL DESCRIPTION

PORTIONS OF LOTS 32 AND 33 PER BIMINI TRACT M.B. 5/133.

EASEMENT NOTE

THERE ARE NO EASEMENTS PER THE ABOVE DESCRIBED TITLE REPORT.

BASIS OF BEARINGS

THE CENTERLINE OF 1ST STREET, BEING N 68°43'00" E PER BIMINI TRACT M.B. 5/33.

BENCH MARK

CITY OF LOS ANGELES BENCH MARK NO. 12-10560 ELEV=280.738
DATUM: NAVD 1988
YEAR OF ADJUSTMENT: 2000

DESCRIPTION: WIRE SPK IN E CURB VERMONT AVE; 1.2FT N/O BC RET N/O 2ND ST.

OFER SHAPIRA
LICENSE NO.: L.S. 7123
EXPIRES: 12/31/2018

12-14-17
DATE

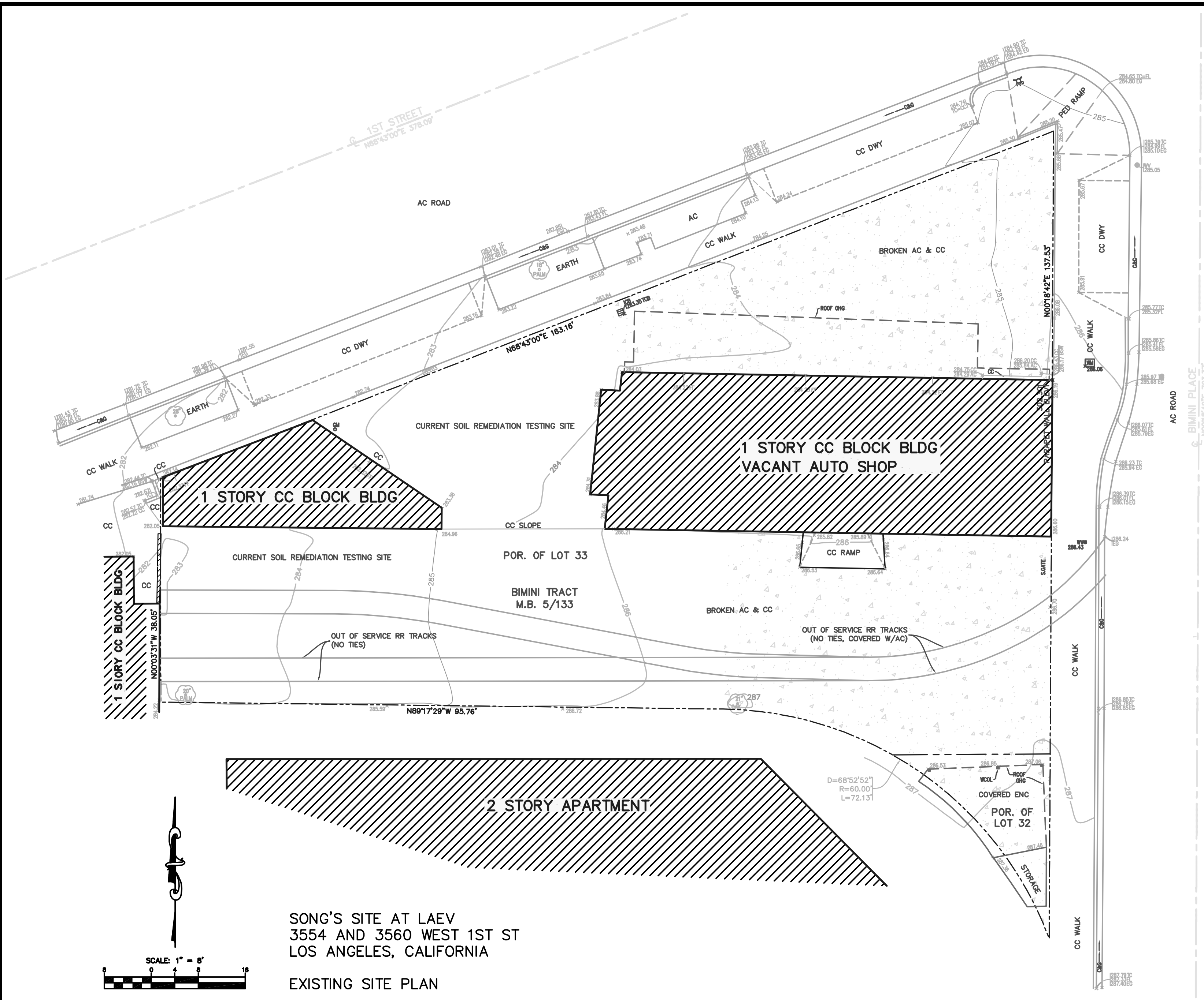
LICENSED LAND SURVEYOR ★ OFER SHAPIRA ★ NO. 7123 ★ Exp. 12-31-18 ★ STATE OF CALIFORNIA

Surveying & Drafting Services, Inc.
901 Seward Street, Los Angeles, CA 90038
Tel: (323) 366-2882 Fax: (323) 857-1079 Email: mailbox@surveyinganddrafting.com
www.surveyinganddrafting.com

TOPOGRAPHIC SURVEY OF 3554 WEST 1ST STREET LOS ANGELES, CALIFORNIA 90004

DATE: 12-14-17	DRAWN BY: A.S., V.L.
DATE OF SURVEY: 11-21-17	CHECKED BY: O.S.
JOB NAME: McILVAINE/ARKIN	SHEET: 1 OF 1

APPENDIX G: Site Drawings



LEGEND

- CENTER LINE
- PROPERTY LINE
- CURB UNLESS OTHERWISE NOTED
- WALL
- COLUMN
- GUARD POST
- SURFACE DRAIN
- FIRE HYDRANT
- TREE WITH TRUNK DIAMETER

ABBREVIATIONS

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ELEV	ELEVATION
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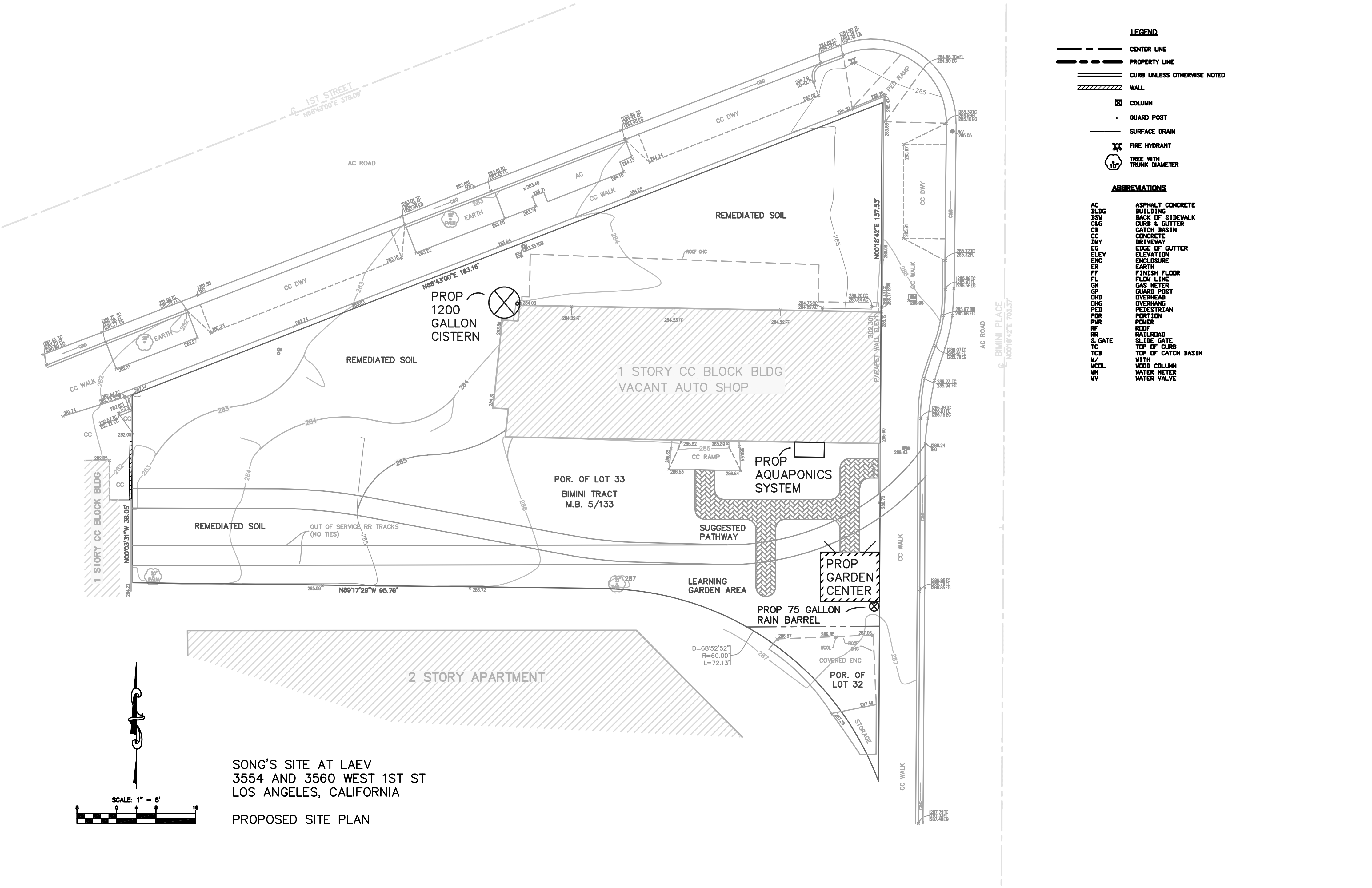
S.GATE	SLIDE GATE
TC	TOP OF CURB
TCB	TOP OF CATCH BASIN
W/	WITH
WCOL	WOOD COLUMN
WM	WATER METER
WV	WATER VALVE

SONG'S SITE AT LAEV
3554 AND 3560 WEST 1ST ST
LOS ANGELES, CALIFORNIA

EXISTING SITE PLAN


LEGEND
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PROPERTY LINE
CURB UNLESS OTHERWISE NOTED
WALL
COLUMN
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PED PEDESTRIAN
POR PORTION
PWR POWER
RF ROOF
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S. GATE SLIDE GATE
TC TOP OF CURB
TCB TOP OF CATCH BASIN
W/ WITH
WCOL WOOD COLUMN
WM WATER METER
WV WATER VALVE
1ST STREET
N68°43'00"E 378.09'
AC ROAD
CC DWY
CC WALK
AC
EARTH
REMEDIATED SOIL
ROOF OHG
N68°43'00"E 163.16'
N00°18'42"E 137.53'
PROP 1200 GALLON CISTERN
1 STORY CC BLOCK BLDG
VACANT AUTO SHOP
PARAPET WALL ELEV 302.30
CC RAMP
PROP AQUAPONICS SYSTEM
POR. OF LOT 33
BIMINI TRACT
M.B. 5/133
SUGGESTED PATHWAY
OUT OF SERVICE RR TRACKS (NO TIES)
1 STORY CC BLOCK BLDG
N00°03'31"W 38.05'
N89°17'29"W 95.76'
LEARNING GARDEN AREA
PROP GARDEN CENTER
PROP 75 GALLON RAIN BARREL
D=68°52'52"
R=60.00'
L=72.13'
COVERED ENC
POR. OF LOT 32
STORAGE
2 STORY APARTMENT
BIMINI PLACE
N00°18'42"E 703.37'
SCALE: 1" = 8'
SONG'S SITE AT LAEV
3554 AND 3560 WEST 1ST ST
LOS ANGELES, CALIFORNIA
PROPOSED SITE PLAN

APPENDIX H: Cost Estimates

Item Details	Amount	Units	Means Cost ($/unit)	Total w/o O&P	Incl O&P ($/unit)	Total w/ O&P	TODAY'S COST
Shear Walls (1/2" thick plywood)	239.7	SF	1.152	$ 276.16	1.536	$ 368.21	$ 278.67
Non-Structural Wall (3/8' plywood)	190.0	SF	0.82	$ 155.80	1.11	$ 210.90	$ 157.21
Floor Sheathing	120.0	SF	0.94	$ 112.80	1.24	$ 148.80	$ 113.82
Polycarbonate Roof Sheathing	144.0	SF	2.77	$ 398.88	3.63	$ 522.72	$ 402.50
Plain Wood Window (1 4x6)	1.0	EA.	869.5	$ 869.50	980	$ 980.00	$ 877.40
Casement Windows (3 5x6)	3.0	EA.	929.5	$ 2,788.50	1050	$ 3,150.00	$ 2,813.83
2 Smooth Wood Doors (3x7 pair)	1.0	EA.	256.5	$ 256.50	315	$ 315.00	$ 258.83
Gravity Load Collectors	48.0	LF	4.6	$ 220.80	6	$ 288.00	$ 222.81
Seismic Holddowns	10.0	EA.	22.83	$ 228.30		$ -	$ 230.37
Gutter, K-type, plain	10.0	LF	5.13	$ 51.30	7.05	$ 70.50	$ 51.77
Gutter Guard (filter)	1.0	EA.	2.72	$ 2.72	3.3	$ 3.30	$ 2.74
3" Dia. Copper Downspout	1.0	EA.	8.51	$ 8.51	10.25	$ 10.25	$ 8.59
Rebar (no 4)	8.0	EA.	21	$ 168.00	27	$ 216.00	$ 169.53
Foundation (concrete footing)	21	SFCA	12.4	$ 260.40	15.4	$ 323.40	$ 262.76
Rafter, 9 (2x6)	100.0	LF	1.07	$ 107.00	1.48	$ 148.00	$ 163.15
Studs, 36 (2x6)	468.0	LF	1.34	$ 627.12	1.88	$ 879.84	$ 956.19
Girders, 2 (4x10)	24.0	LF	5.77	$ 138.48	7.1	$ 170.40	$ 211.14
Floor Joists, 11 (2x6)	132.0	LF	0.96	$ 126.72	1.3	$ 171.60	$ 193.21
Exterior Wall	429.7	SF	2.64	$ 1,134.46	3.49	$ 1,499.73	$ 1,729.75
						Total	$ 9,104.27

Item Details	Amount	Units	Means Cost ($/unit)	Total w/o O&P	Incl O&P ($/unit)	Total w/ O&P	TODAY'S COST
Excavation	108.11	C.Y.	3.5	378.39	4.2	454.06	381.82
Loading	108.11	C.Y.	17.6	1902.74	19.5	2108.15	1920.02
Hauling	108.11	C.Y.	6	648.66	7.6	821.64	654.55
Fill	113.74	C.Y.	3.4	386.72	4.7	534.58	390.23
						Total	$ 3,346.62

Item Details	Amount	Units	Means Cost ($/unit)	Total w/o O&P	Incl O&P ($/unit)	Total w/ O&P	TODAY'S COST
1200 gallon cistern							$ 1,453.50
75 gallon rain barrel							$ 496.44
Hose	2	EA.					$ 49.98
6" concrete slab for cistern	1.1	C.Y.	16.27	$ 18.10	24.5	$ 27.25	$ 27.59
6" concrete slab for barell	0.2	C.Y.	16.27	$ 2.71	25.5	$ 4.25	$ 2.74
Anchor (small)	2	EA.	7	$ 14.00	10.1	$ 20.20	$ 14.13
Steel Plate	6.3	S.F.	33.5	$ 209.38	36.5	$ 228.13	$ 211.28
Anchor (large)	12	EA.	7	$ 84.00	10.1	$ 121.20	$ 84.76
Steel Plate	44.4	S.F.	33.5	$ 1,488.89	36.5	$ 1,622.22	$ 1,502.41
3" elbows	7	EA.	16.6	$ 116.20	23	$ 161.00	$ 117.26
4" elbows	7	EA.	19.1	$ 133.70	25.5	$ 178.50	$ 134.91
3" piping	10	L.F.	1.3	$ 13.00	1.7	$ 17.00	$ 13.12
4" piping	12	L.F.	1.5	$ 18.00	1.9	$ 22.80	$ 18.16
Gutter Guard (filter)	1.0	EA.	2.72	$ 2.72	3.3	$ 3.30	$ 2.74
						Total	$ 4,129.02

Item Details	Amount	Units	Means Cost ($/unit)	Total w/o O&P	Incl O&P ($/unit)	Total w/ O&P	TODAY'S COST
Tilapia	20		-				$ 30.00
Fish Tank	270	GAL	-				$ 1,310.00
Media Tanks (1-2)	51	GAL	-				$ 1,214.00
Media Tank 3	135		-				$ 877.00
Piping (3/4" pvc)	14	LF	1.3	$ 18.20	1.7	$ 23.80	$ 18.04
Pump	1	EA.	-				$ 66.99
Air Stones	7		-				$ 102.62
Heater			-				$ 65.99
Media (Lava Stone)	142.2	GAL	-				$ 326.82
Elbow Fittings	7		-				$ 5.53
Tee Fittings	4		-				$ 3.28
Aerator (1000 L/H)	1	EA.					$ 36.99
Concrete Slab	0.8	C.Y.	16.27	$ 12.86	24.5	$ 19.36	$ 8.43
Structural							
Girders (2x10)	30	LF	2	$ 60.00	2.72	$ 81.60	$ 39.35
Columns (4x4)	34	LF	2.85	$ 96.90	3.92	$ 133.28	$ 63.55
Beams (2x6)	48	LF	1.3	$ 62.40	1.86	$ 89.28	$ 40.93
Anchor	2	EA.	7	$ 14.00	10.1	$ 20.20	$ 13.87
Steel Plate	0.5	SF	33.5	$ 16.75	36.5	$ 18.25	$ 16.60
Waterproofing	1680	SF	0.98	$ 1,646.40	1.2	$ 2,016.00	$ 1,631.58
Shear Walls (1/2" plywood sheathing)	72	SF	0.96	$ 69.12	1.28	$ 92.16	$ 45.33
						Total	$ 5,916.90

APPENDIX I: CEQA Checklist

Instructions
Pages 1-3 are only needed when preparing a "checklist" IS. If the checklist will be used in the CEQA environmental document, proceed directly to Page 4 and use that as the beginning of the checklist and follow the guidance in the annotated outlines. Remove instructions before finalizing.

CEQA Environmental Checklist

PROJECT DESCRIPTION AND BACKGROUND

Project Title: Songs at LAEV

Lead agency name: Eco-Lions Engineering **Address:** 1 LMU Dr, Los Angeles, CA 90045

Contact person: Kristin Hernandez **Phone number:** (310) 338 - 2700

Project sponsor's name: Joseph Reichenberger

Address: 1 LMU Dr, Los Angeles, CA

Project Location: 3554 W 1st St, Los Angeles, CA 90004

General plan description: The current site is a Brownfield site, but the project is made with the assumption that remediation will be complete upon implementation, and currently existing asphalt will be removed. An existing café will also be demolished. This will make the site completely pervious, aside from the existing retrofitted auto shop/community hub, and newly implemented garden shed structure.

Zoning: C1.5

Description of project:

The existing "Songs at LAEV" site is being re-developed to include an above-ground rainwater storage and use system, aquaponics system, and re-designed learning garden with a shed structure. There are no off-site features necessary for implementation.

Surrounding land uses and setting:

The site is located within the Los Angeles Eco-Village neighborhood, made up of the two blocks of Bimini and White House Place in the northern end of the Koreatown area. The "Songs at LAEV" site is located on the corner of West 1st St, adjacent to the community housing co-op. The surrounding area is metropolitan, and there is a school located across the street from the community.

Other public agencies whose approval is required (e.g. permits, financial approval, or participation agreements)**:**

LA County Department of Public Health, LA Department of Public Works

NATIVE AMERICAN CONSULTATION

Have California Native American tribes traditionally and culturally affiliated with the project area requested consultation pursuant to Public Resources Code (PRC) section 21080.3.1? ☐ **Yes** ☒ **No**

If yes, ensure that consultation and heritage resource confidentiality follow PRC sections 21080.3.1 and 21080.3.2 and California Government Code 65352.4

Note: Conducting consultation early in the CEQA process allows tribal governments, lead agencies, and project proponents to discuss the level of environmental review, identify and address potential adverse impacts to tribal cultural resources, and reduce the potential for delay and conflict in the environmental review process. (See Public Resources Code section 21080.3.2.) Information may also be available from the California Native American Heritage Commission's Sacred Lands File per Public Resources Code section 5097.96 and the California Historical Resources Information System administered by the California Office of Historic Preservation. Please also note that Public Resources Code section 21082.3(c) contains provisions specific to confidentiality.

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project. Please see the checklist beginning on page 4 for additional information.

☐ Aesthetics	☐ Agriculture and Forestry
☐ Air Quality	☐ Biological Resources
☐ Cultural Resources	☐ Energy
☒ Geology/Soils	☐ Greenhouse Gas Emissions
☐ Hazards and Hazardous Materials	☐ Hydrology/Water Quality
☐ Land Use/Planning	☐ Mineral Resources
☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation
☐ Transportation	☐ Tribal Cultural Resources
☐ Utilities/Service Systems	☐ Wildfire
☐ Mandatory Findings of Significance	

DETERMINATION

On the basis of this initial evaluation (choose one):

☒ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Kristin Hernandez	[signature]	4/4/2023
Print Name	Signature	Date

CEQA Environmental Checklist

DIST-CO-RTE: N/A **PM/PM:** N/A **EA/Project No.:**CIVL461

This checklist identifies physical, biological, social and economic factors that might be affected by the proposed project. In many cases, background studies performed in connection with the projects indicate no impacts. A NO IMPACT answer in the last column reflects this determination. Where there is a need for clarifying discussion, the discussion is included either following the applicable section of the checklist or is within the body of the environmental document itself. The words "significant" and "significance" used throughout the following checklist are related to CEQA, not NEPA, impacts. The questions in this form are intended to encourage the thoughtful assessment of impacts and do not represent thresholds of significance.

Instructions

Click on "Choose an item" under the CEQA Determination column to select the appropriate significance determination from the drop-down list. If discussions will be included after each resource table, follow the guidance provided in the annotated outlines.

AESTHETICS

Except as provided in Public Resources Code Section 21099, would the project:

Question	CEQA Determination
a) Have a substantial adverse effect on a scenic vista?	No Impact
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	No Impact
c) In non-urbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings? (Public views are those that are experienced from a publicly accessible vantage point). If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?	No Impact
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	No Impact

AGRICULTURE AND FOREST RESOURCES

In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of

Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project; and the forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the project:

Question	CEQA Determination
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	No Impact
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	No Impact
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?	No Impact
d) Result in the loss of forest land or conversion of forest land to non-forest use?	No Impact
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?	No Impact

AIR QUALITY

Where available, the significance criteria established by the applicable air quality management district or air pollution control district may be relied upon to make the following determinations. Would the project:

Question	CEQA Determination
a) Conflict with or obstruct implementation of the applicable air quality plan?	No Impact
b) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard?	No Impact
c) Expose sensitive receptors to substantial pollutant concentrations?	No Impact
d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?	No Impact

BIOLOGICAL RESOURCES

Would the project:

Question	CEQA Determination
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, or NOAA Fisheries?	No Impact
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service?	No Impact
c) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	No Impact
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	No Impact
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	No Impact
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	No Impact

CULTURAL RESOURCES

Would the project:

Question	CEQA Determination
a) Cause a substantial adverse change in the significance of a historical resource pursuant to in §15064.5?	No Impact
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	No Impact
c) Disturb any human remains, including those interred outside of dedicated cemeteries?	No Impact

ENERGY

Would the project:

Question	CEQA Determination
a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?	No Impact
b) Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	No Impact

GEOLOGY AND SOILS

Would the project:

Question	CEQA Determination
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving: i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	No Impact
ii) Strong seismic ground shaking?	Less Than Significant with Mitigation Incorporated
iii) Seismic-related ground failure, including liquefaction?	Less Than Significant Impact
iv) Landslides?	No Impact
b) Result in substantial soil erosion or the loss of topsoil?	No Impact
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	Less Than Significant Impact
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?	Less Than Significant Impact
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	No Impact
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	No Impact

GREENHOUSE GAS EMISSIONS

Would the project:

Question	CEQA Determination
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	No Impact
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	No Impact

HAZARDS AND HAZARDOUS MATERIALS

Would the project:

Question	CEQA Determination
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	No Impact
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	No Impact
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	No Impact
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	No Impact
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	No Impact
f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	No Impact
g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires?	No Impact

HYDROLOGY AND WATER QUALITY

Would the project:

Question	CEQA Determination
a) Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality?	No Impact
b) Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such the project may impede sustainable groundwater management of the basin?	No Impact
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner which would: (i) result in substantial erosion or siltation on- or off-site;	No Impact
(ii) substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite;	No Impact
(iii) create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or	No Impact
(iv) impede or redirect flood flows?	No Impact
d) In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation?	No Impact
e) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?	No Impact

LAND USE AND PLANNING

Would the project:

Question	CEQA Determination
a) Physically divide an established community?	No Impact
b) Cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?	No Impact

MINERAL RESOURCES

Would the project:

Question	CEQA Determination
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	No Impact
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	No Impact

NOISE

Would the project result in:

Question	CEQA Determination
a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	No Impact
b) Generation of excessive groundborne vibration or groundborne noise levels?	No Impact
c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	No Impact

POPULATION AND HOUSING

Would the project:

Question	CEQA Determination
a) Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	No Impact
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?	No Impact

PUBLIC SERVICES

Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the following public services:

Question	CEQA Determination
a) Fire protection?	No Impact
b) Police protection?	No Impact
c) Schools?	No Impact
d) Parks?	No Impact
e) Other public facilities?	No Impact

RECREATION

Question	CEQA Determination
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	No Impact
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	No Impact

TRANSPORTATION

Would the project:

Question	CEQA Determination
a) Conflict with a program, plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities?	No Impact
b) Would the project conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?	No Impact
c) Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	No Impact
d) Result in inadequate emergency access?	No Impact

TRIBAL CULTURAL RESOURCES

Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:

Question	CEQA Determination
a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k), or	No Impact
b) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resource Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.	No Impact

UTILITIES AND SERVICE SYSTEMS

Would the project:

Question	CEQA Determination
a) Require or result in the relocation or construction of new or expanded water, wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects?	No Impact
b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?	No Impact
c) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	No Impact
d) Generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?	No Impact
e) Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?	No Impact

WILDFIRE

If located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the project:

Question	CEQA Determination
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?	No Impact
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	No Impact
c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?	No Impact
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?	No Impact

MANDATORY FINDINGS OF SIGNIFICANCE

Question	CEQA Determination
a) Does the project have the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	No Impact
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	No Impact
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	No Impact

APPENDIX J: Mentor and Client Correspondence

LAEV CAPSTONE MENTOR AND CLIENT CORRESPONDENCE

November 11, 2022 Mentor Meeting with Dr. Brianna Pagán

- •Attendees: Kendall Gilbert, Kristin Hernandez, Gia Morelli, Brianna Pagán, Marina Rios.
- •Outcomes: Brainstorming project ideas and planning community outreach to find a client.

December 8, 2022 Client Meeting with Lois Arkin

- •Attendees: Lois Arkin, Kendall Gilbert, Kristin Hernandez, Gia Morelli, Marina Rios.
- •Outcomes: Introduction to Los Angeles Eco-village, overview for potential sites and design points to include in project scope.

January 16, 2023 Client Meeting with Lois Arkin

- •Attendees: Lois Arkin, Kendall Gilbert, Kristin Hernandez, Gia Morelli, Marina Rios.
- •Outcomes: Finalizing design ideas and project scope in relation to community needs.

January 28, 2023 Site Visit at the LAEV

- •Attendees: Lois Arkin, Kendall Gilbert, Kristin Hernandez, James Jeon, Marina Rios.
- •Outcomes: Site tour and inspection of Song's site, introductions to some key community members.

February 14, 2023 Advisory Meeting with Dr. Joseph Reichenberger and Dr. Negin Tauberg

- •Attendees: Kendall Gilbert, Kristin Hernandez, Gia Morelli, Marina Rios, Joseph Reichenberger, Negin Tauberg.
- •Outcomes: Finalizing deliverables expected for future submittals, approving project scope and design elements with project requirements.

March 14, 2023 Mentor Meeting with Dr. Joseph Reichenberger and Dr. Brianna Pagán

- •Attendees: Kendall Gilbert, Kristin Hernandez, Gia Morelli, Brianna Pagán, Joseph Reichenberger, Marina Rios.
- •Outcomes: Discussing scope for site utilities and runoff collection, adjusting brownfield site assumptions.

LAEV CAPSTONE MENTOR AND CLIENT CORRESPONDENCE

March 17, 2023 Mentor Meeting with Dr. Maria Elena Giner

- Attendees: Kendall Gilbert, Maria Giner, Kristin Hernandez, Gia Morelli, Marina Rios.
- Outcomes: Mentor introduction, overview of first submittal, recieving feedback on preliminary design report to make adjustments for second submittal.

March 24, 2023 Mentor Meeting with Dr. Brianna Pagán

- Attendees: Kendall Gilbert, Kristin Hernandez, Gia Morelli, Brianna Pagán.
- Outcomes: Discussion of scope for geospatial hydrology assistant project, introduction to softwares and packages to include in final code.

March 24, 2023 Mentor Meeting with Dr. Maria Elena Giner

- Attendees: Kendall Gilbert, Maria Giner, Kristin Hernandez, Gia Morelli, Marina Rios.
- Outcomes: Discussions of new site plan, discussion of minor adjustments for new assumptions and design changes.

March 24, 2023 Client Meeting with Gideon Susman and Lois Arkin

- Attendees: Lois Arkin, Kendall Gilbert, Kristin Hernandez, Gia Morelli, Marina Rios, Gideon Susman.
- Outcomes: Overview of first submittal and current design elements, recieving feedback on design changes to improve utility of designs for the LAEV community, clarifying community objectives.

March 31, 2023 Mentor Meeting with Dr. Maria Elena Giner

- Attendees: Kendall Gilbert, Maria Giner, Kristin Hernandez, Gia Morelli, Marina Rios.
- Outcomes: Discussion on presentation of ideas, finalizing site plan, final feedback on design report for second submittal due 4/4.

ECO-LIONS ENGINEERING WOULD LIKE TO THANK THE ABOVE LISTED MENTORS, CLIENTS, AND LAEV COMMUNITY MEMBERS FOR THEIR GUIDANCE AND SUPPORT THROUGHOUT THIS PROJECT.

From: **Maria Elena Giner** mariaelena.giner@ibwc.gov
Subject: RE: First Draft of Capstone Design Report
Date: April 15, 2023 at 4:46 PM
To: Mireles Rios, Marina mmirele2@lion.lmu.edu, Morelli, Gianna gmorelli@lion.lmu.edu
Cc: Gilbert, Kendall kgilbe11@lion.lmu.edu, Hernandez, Kristin kherna42@lion.lmu.edu

MG

EXTERNAL EMAIL: Do not open attachments or click on links if you do not recognize the sender.

This message classified as **Personal**

Hi Ladies,
This was an excellent draft. I am attaching my comments. Hopefully you find these helpful. I have time on Sunday (pretty flexible so name a time) or Monday after 6pm PT. Also thank you for the well wishes.

Warm regards,

Dr. Maria-Elena Giner, P.E. (She/Her/Hers)
Commissioner (U.S. Section)
International Boundary and Water Commission, United States and Mexico
United States Section
4191 N. Mesa Street
El Paso, TX 79902-1423
(915) 832-4100
mariaelena.giner@ibwc.gov
https://ibwc.gov/home.html

"Pleasure in the job puts perfection in the work." - Aristotle

From: **Tauberg, Negin** Negin.Tauberg@lmu.edu
Subject: LA EcoVillage Second Progress Submittal
Date: April 15, 2023 at 6:24 PM
To: Morelli, Gianna gmorelli@lion.lmu.edu, Gilbert, Kendall kgilbe11@lion.lmu.edu, Mireles Rios, Marina mmirele2@lion.lmu.edu, Hernandez, Kristin kherna42@lion.lmu.edu
Cc: Reichenberger, Joseph Joseph.Reichenberger@lmu.edu

NT

Hi ladies,

Please see attached for my input (red markups) throughout the pdf report (majority in Chapter 3) to incorporate for the final submittal.

Marina, for the presentation it would be good to show a loading criteria table for the garden structure as well as some visual snapshots e.g., floor plan , roof plan (showing typical rafter size/spacing and girder size, wall lengths) , section views of door/windows and slope of roof, etc.

If you have any questions, feel free to contact me.

Best,

Negin A. Tauberg, Ph.D., P.E.
Visiting Assistant Professor
Department of Civil Engineering & Environmental Science
Seaver College of Science and Engineering
LMU|LA Loyola Marymount University

Pereira Hall 132
1 LMU Drive
Los Angeles, CA 90045-2659
Office: 310-338-5880

From: Tauberg, Negin <Negin.Tauberg@lmu.edu>
Sent: Thursday, March 16, 2023 1:14 PM
To: Morelli, Gianna <gmorelli@lion.lmu.edu>; Gilbert, Kendall <kgilbe11@lion.lmu.edu>; Mireles Rios, Marina <mmirele2@lion.lmu.edu>; Hernandez, Kristin <kherna42@lion.lmu.edu>
Cc: Reichenberger, Joseph <Joseph.Reichenberger@lmu.edu>
Subject: Re: LA Ecovillage First Submittal

Hi ladies,

Please see attached for some markups (in red) for your project (mostly for section 3). This pdf includes Professor Reichenberger's input in the yellow rectangles as well.

Best,

Negin A. Tauberg, Ph.D., P.E.
Visiting Assistant Professor
Department of Civil Engineering & Environmental Science
Seaver College of Science and Engineering
LMU|LA Loyola Marymount University

Pereira Hall 132
1 LMU Drive
Los Angeles, CA 90045-2659
Office: 310-338-5880

From: Tauberg, Negin <Negin.Tauberg@lmu.edu>

From: Tauberg, Negin <Negin.Tauberg@lmu.edu>
Sent: Monday, February 20, 2023 10:31 PM
To: Morelli, Gianna <gmorelli@lion.lmu.edu>; Gilbert, Kendall <kgilbe11@lion.lmu.edu>; Mireles Rios, Marina <mmirele2@lion.lmu.edu>; Hernandez, Kristin <kherna42@lion.lmu.edu>
Cc: Reichenberger, Joseph <Joseph.Reichenberger@lmu.edu>
Subject: Re: LA Ecovillage First Submittal

Hello team,

From an overall view of your draft, I see that you have the main design considerations included and summarized, so that's good; but you do have plenty of design work to do (design details in some sections not started/pending).

Keep working on finalizing the various design tasks. I will mentor Marina on the shed structure design and getting information from Appendix E calcs summarized into the main report.

In your overall site/tank designs, also refer to ASCE 7-16 Chapter 13 for seismic anchorage of applicable items (for example, a tank that weighs more than 400# needs to be seismically anchored).

Best,

Negin A. Tauberg, Ph.D., P.E.
Visiting Assistant Professor
Department of Civil Engineering & Environmental Science
Seaver College of Science and Engineering
LMU|LA Loyola Marymount University

Pereira Hall 132
1 LMU Drive
Los Angeles, CA 90045-2659
Office: 310-338-5880

From: Morelli, Gianna <gmorelli@lion.lmu.edu>
Sent: Monday, February 20, 2023 9:59 PM
To: Reichenberger, Joseph <Joseph.Reichenberger@lmu.edu>; Tauberg, Negin <Negin.Tauberg@lmu.edu>
Cc: Gilbert, Kendall <kgilbe11@lion.lmu.edu>; Mireles Rios, Marina <mmirele2@lion.lmu.edu>; Hernandez, Kristin <kherna42@lion.lmu.edu>
Subject: LA Ecovillage First Submittal

Dr. Reichenberger and Dr. Tauberg,

Please find our first submittal PDR attached to this email. Dr. Tauberg has agreed to fulfill the QA/QC form requirement for this submittal.

Thank you for your help so far and we look forward to your feedback as we continue to develop this exciting project.

Best

Gia Morelli
Senior Undergraduate Student

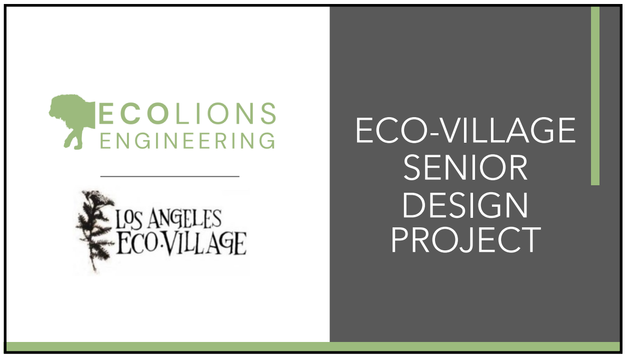
Civil Engineering
Frank R. Seaver College of Science and Engineering

Loyola Marymount University

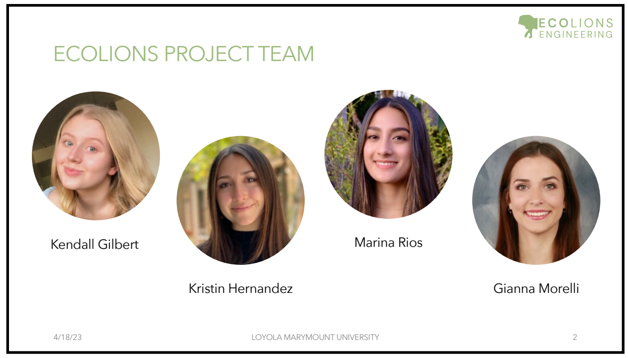
Mobile 509.869.0104
Email gmorelli@lion.lmu.edu

LA EcoVillage Lions_FDR.pdf

APPENDIX K: Presentation and Poster Board


ECOLIONS
ENGINEERING
LOS ANGELES
ECO-VILLAGE
ECO-VILLAGE SENIOR DESIGN PROJECT

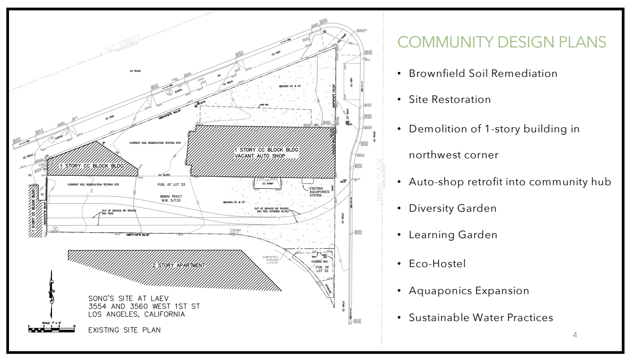
1


ECOLIONS ENGINEERING
ECOLIONS PROJECT TEAM
Kendall Gilbert
Kristin Hernandez
Marina Rios
Gianna Morelli
4/18/23
LOYOLA MARYMOUNT UNIVERSITY
2

2


ECOLIONS ENGINEERING
BACKGROUND
Project Location: 3554 West 1st Street, Los Angeles CA
Site Area: 0.252 acres
The LAEV wishes to redevelop this property into a thriving multipurpose community hub to provide tenants with useful amenities and visitors with the opportunity to learn about sustainable urban living.
W 1st St
Songs at LA Eco-Village
Berendo Pl
4/18/23
LOYOLA MARYMOUNT UNIVERSITY
3

3


1 STORY CC BLOCK BLDG
VACANT AUTO SHOP
1 STORY CC BLOCK BLDG
2 STORY APARTMENT
SONG'S SITE AT LAEV
3554 AND 3560 WEST 1ST ST
LOS ANGELES, CALIFORNIA
EXISTING SITE PLAN
COMMUNITY DESIGN PLANS
Brownfield Soil Remediation
Site Restoration
Demolition of 1-story building in northwest corner
Auto-shop retrofit into community hub
Diversity Garden
Learning Garden
Eco-Hostel
Aquaponics Expansion
Sustainable Water Practices
4

4


ECOLIONS ENGINEERING
COMMUNITY OBJECTIVES
01
The design should cultivate new, highly sustainable, and resilient ideas on urban living.
02
The design should incorporate educational elements to inspire visitors and tenants to live more sustainably.
03
The design should fit within the schedule and scope of existing community plans.
04
The design should minimize costs.
4/18/23
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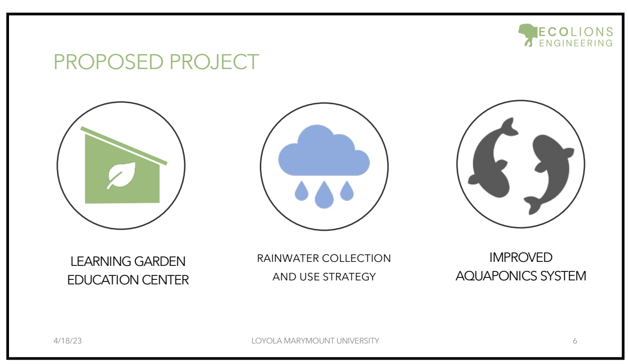
5

5


ECOLIONS ENGINEERING
PROPOSED PROJECT
LEARNING GARDEN
EDUCATION CENTER
RAINWATER COLLECTION
AND USE STRATEGY
IMPROVED
AQUAPONICS SYSTEM
4/18/23
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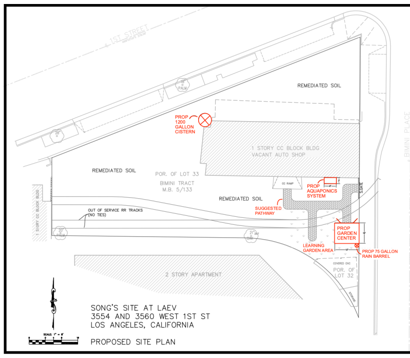
6

6



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PROPOSED SITE PLAN

7

7

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SUSTAINABLE ELEMENTS

EXISTING	PROPOSED
• Reduced parking footprint, with access to quality transit (bus stops and bike racks) • On-site composting • Community environmental education • Solar panels to be placed on retrofitted auto shop/community hub	• Site is to follow LID requirements for rainwater recapture • Learning Garden opportunity • Aquaponics system for urban agriculture • Opportunity for solar panels to be placed on Garden Education Center • "On-site" and recycled materials

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ECOLIONS ENGINEERING

DESIGN CRITERIA AND CODES

Structural Design

- 2018 International Building Code (IBC)
- ASCE 7-16
- NDS for Wood Construction 2018
- SDPWS by American Wood Council 2021
- Los Angeles City Building Code 2022
- Los Angeles Department of City Planning Zoning Regulations
- Los Angeles Department of Building and Safety

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DESIGN CRITERIA AND CODES

Stormwater Management

- Los Angeles County Department of Public Works Low Impact Development Manual
- Los Angeles Sanitation Low Impact Development Handbook

Public Works LOS ANGELES COUNTY

LASAN

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LEARNING GARDEN AND EDUCATION CENTER

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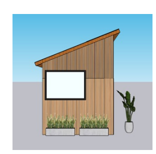
CONCEPTUAL DESIGN

Isometric View

Front View (North Wall)



Side View (West Wall)

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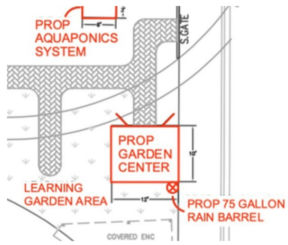
LAYOUT



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ECOLIONS ENGINEERING

1. Make material selection and determine preliminary structural member dimensions based on conceptual design.
2. Determine Loads including Dead, Live, Wind, Seismic, Snow and Rain Loads per ASCE 7-16.
3. Select trial sizes for each member.
4. Check member capacities such as shear, bending, axial compression and deflection per LRFD and NDS regulations.
5. Compare member capacity to member demand. Resize member if necessary.

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STRUCTURAL MATERIALS SELECTION

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Framing Member	Material Selection
Roof Rafters	No. 1 Douglas Fir
Roof Girders	No. 1 Douglas Fir
Wall Studs	No. 1 Douglas Fir
Roof Studs	No. 1 Douglas Fir
Foor Joists	No. 1 Douglas Fir

SFRS Member	Material Selection
Shear Wall Panels	Plywood
Non-Structural Panels	Plywood

Roofing/Flooring	Material Selection
Roof Sheathing	Polycarbonate Paneling
Floor Sheathing	Plywood
Foundation	Reinforced Concrete

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ROOF LOADING

ECOLIONS ENGINEERING

Roof Dead Load	
Material Type	*Weight (psf)*
Roof Paneling	1.93
Girders	1.5
Rafters	6
Utilities/Lights	2
Solar Panels	2
Total	13.43
Rounded Total	**13.5**

Roof Live Load	
Lo (psf)	20.0
Reducible?	Yes
At (sf)	16.2
Total Rise of Roof (in)	48.0
Roof Span in Direction of Slope (ft)	10.0
F	4.80
R1	1.0
R2	0.96
Lr (psf)	**19.2**

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ROOF DRAINAGE DESIGN AND RAIN LOAD

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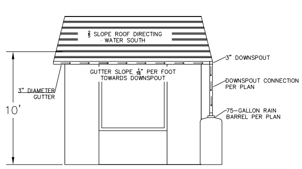

Rain Load	
60 min/100 yr Storm Intensity (in/hr)	2
15 min/100 yr Storm Intensity (in/hr)	1
A of the roof (sq ft)	153.2
Primary Drainage System	3" Gutter at 1/16" per foot slope
Secondary Drainage System	Open Sided Roof
Q Roof (gpm)	3.2
Roof Drainage Length (ft)	12
Ai/400 <= Roof Drainage Length	Yes
Hydraulic head (in)	0
Static Head (in)	0
R (psf)	**0**

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WIND LOADS

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Wind Design Parameters	
Exposure Category	B
Elevation (ft)	286
Maximum Structure Height (ft)	14
V (mph)	88
Ke	1
Kd	0.85
Kz for h=0-15'	0.57
Kzt	1
qi=0.00256KzKdKeKztV^2	9.6

MWFRS Wind Pressures			
N-S Direction (psf)		*E-W Direction (psf)*	
Walls, Windward, h=0-14'	8.3	Walls, Windward, h=0-14'	8.3
Walls, Leeward	-2.4	Walls, Leeward	-5.5
Walls, Sidewalls	-4.0	Walls, Sidewalls	-7.4
Roof, Windward	-6.9	Roof, Windward, 0'-7'	-12.0
Roof, Leeward	-6.6	Roof, Windward, 7'-14'	-7.4
Worst Case Wind Pressure (psf)		**-12.0**	

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ECOLIONS ENGINEERING

SEISMIC BASE SHEAR ANALYSIS AND LRFD LOADS

Seismic Design Parameters	
Building Occupancy Risk Category	I
I_e	1
Site Class	D
S_s	2.02
S_1	0.72
F_a	1.2
F_v	1.7
S_{ms}	2.43
S_{m1}	1.23
S_{DS}	1.62
S_{D1}	0.82
T_L (s)	8
SDC	D

Seismic Base Shear Analysis per ELF	
Governing C_s	0.25
Seismic Weight (k)	2.57
Base Shear (k)	0.64
Adjusted Base Shear for Default Site Class (k)	**0.96**

Seismic Load Effects and Combinations	
SFRS	A15
E_v (psf)	4.37
E_h (psf)	8.14
E_{mh} (psf)	18.78
E_m (psf)	14.41

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ECOLIONS ENGINEERING

LOAD SUMMARY AND LRFD COMBINATIONS

Load Summary	Weight (psf)
Dead (D)	13.5
Live (L)	0
Rood Live (Lr)	19.2
Rain (R)	0
Snow (S)	0
Wind (W)	11.97
Seismic (Ev)	4.37
Seismic (Eh)	8.14
Seismic (Emh)	18.78
Seismic (Em)	14.41

LRFD Load Combinations per ASCE 7-16	Roof (psf)
1.4D	18.9
1.2D+1.6L+0.5Lr	25.8
1.2D+1.6L+0.5S	16.2
1.2D+1.6L+0.5R	16.2
1.2D+1.6Lr+L	46.9
1.2D+1.6S+L	16.2
1.2D+1.6R+L	16.2
1.2D+1.6Lr+0.5W	52.9
1.2D+1.6S+0.5W	22.2
1.2D+1.6R+0.5W	22.2
1.2D+W+L+0.5Lr	37.8
1.2D+W+L+0.5S	28.2
1.2D+W+L+0.5R	28.2
0.9D+W	24.1
1.2D+Ev+Eh+L+0.2S	28.7
0.9D-Ev+Eh	15.9
1.2D+Ev+Emh+L+0.2S	39.4
0.9D-Ev+Emh	26.6
Maximum Load Combination	**53**

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STRUCTURAL FRAMING SIZES

Sizing Summary		
Member Type	*Quantity*	*Member Size*
Rafters	9	2x6
Studs	36	2x6
Girders	2	4x10
Floor Joists	11	2x6

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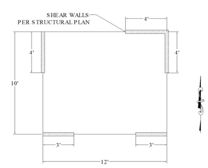
SFRS DESIGN



Shear Wall Placement Plan View

Shear Wall Material Specifications	
Material	Plywood Sheathing Structural Panel
Wood Specification	STRUCTURAL 1
Thickness (in)	0.375
Minimum Nail Bearing Length in Framing and Blocking	1.375
Panel Nail Edge Spacing (in)	6
Vs (plf)	645
Ga (k/in)	14

Seismic Hold Down Material Specifications	
Installation	Post Pour
Connection Materials	Wood to Concrete
SST Heavy Tension Tie	HTT4
Anchor Rod Diameter (in)	0.625
Wood Fasteners (in)	(18) #19 by 1.5" SD
Min Wood Member Size (in)	2 by 6
Allowable Tension Load (lb)	4455

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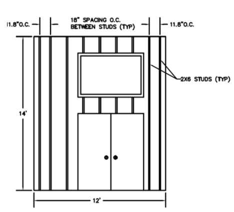
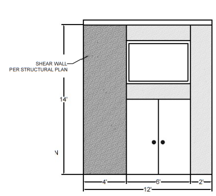
ELEVATION VIEW – NORTH WALL



Framing Plan for North Wall



Shear Wall Plan for North Wall

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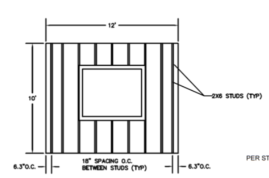
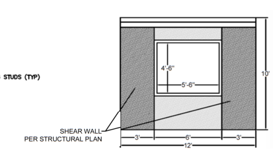
ELEVATION VIEW – SOUTH WALL



Framing Plan for South Wall



Shear Wall Plan for South Wall

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ELEVATION VIEW – EAST AND WEST WALLS

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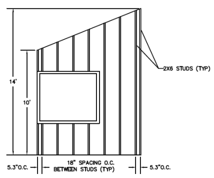
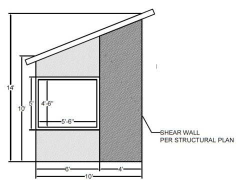


Framing Plan for East/West Walls



Shear Wall Plan for East/West Walls

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ELEVATION VIEW – ROOF

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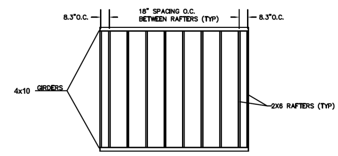

Framing Plan for Roof

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SOIL PROPERTIES

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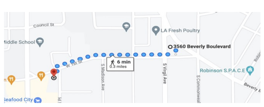
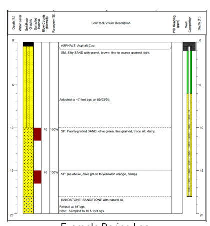
- Soil Classification: SM
- Average Blow Count (Cal MOD SS to SPT): 24
- Moist Unit Weight: 120 pcf
- Approximate Friction Angle: 39°





Example Boring Log

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FOUNDATION DESIGN

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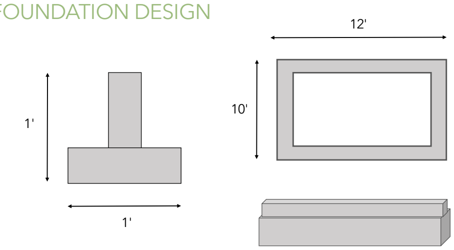

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ADA REGULATIONS

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- Designed in accordance with the Americans with Disabilities Act (ADA)
- On-site door will be the side swinging type with a direct and obvious exit path.
- Door dimensions will be 7' x 6' in accordance with S3235 of the California ADA.
- Door hardware mounted 48" above floor in accordance with S3235 of the California ADA.

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DESIGN ALTERNATIVES CONSIDERED

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Greenhouse Structure

- Pros: Unique design, extended grow season, energy efficient.
- Cons: Poor lighting limits functionality, Los Angeles already has a year-round grow season.

Pitched Roof

- Pros: Simple design.
- Cons: Complicates rainwater collection system.

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LEARNING GARDEN FUTURE RECCOMENDATIONS

- Suggested pathway from recycled bricks.
- Vegetable washing station.
- Solar panels.

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RAINWATER COLLECTION, STORAGE, AND USE

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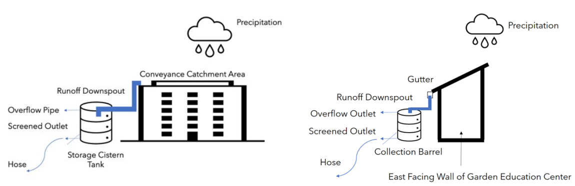
CONCEPTUAL DESIGN



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LOW IMPACT DEVELOPMENT

Designated Redevelopment Project - Development resulting in the replacement of 5,000 square feet of impervious surface on a site previously developed as an automotive service facility.

Less than 50 percent of the impervious surface is proposed to be altered and the previous development was not subject to post-construction stormwater quality control measures.

Only the proposed alteration must meet the requirements of the LID Standards Manual.

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1. Conduct site assessment to identify feasibility and design considerations.

2. Apply site specific source control measures.

3. Calculate the stormwater quality design volume.

4. Implement stormwater quality control measures.

5. Implement any further compliances/requirements.

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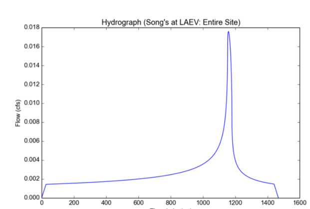
SITE HYDROLOGY ASSESSMENT



	Cubic Feet	Gallons
Total Site Runoff	237.1	1744.6
Rainwater Collection Volume	163.8	1225.0

	Cubic Feet per Second (cfs)	Gallons Per Minute (gpm)
Peak Flow Rate	0.0176	7.90

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CAPTURE AND USE FEASABILITY

- Estimated Total Water Use for irrigation for the 7-month wet period October 1st to April 30th
- Using standard planting factor of 0.3 and average 7-month evapotranspiration value of 21.7

$$ETWU_{7month} \geq Vdesign$$

35,673 gallons ≥ 1160 gallons

Capture and use is a feasible BMP option.

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NON-POTABLE WATER USES

ON-SITE IRRIGATION

- Learning Garden (proposed)
- Diversity Garden (future)
- LAEV Property (existing)

OTHER ON-SITE USES

- Aquaponics system (proposed)
- Vegetable washing station (future)

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TANK SIZING

	Rainwater Collection Volume (gallons)	Tank Size (gallons)
Songs Building Roof	1192.6	1200
Garden Center Roof	72.8	75

Tank Size (gallons)	Diameter (in)	Height (in)
1200	76	66
75	23	50

www.ProTank.com

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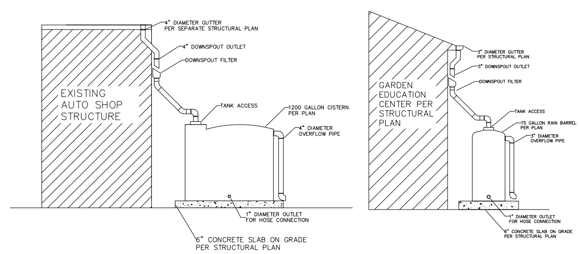
CONNECTION DETAILS



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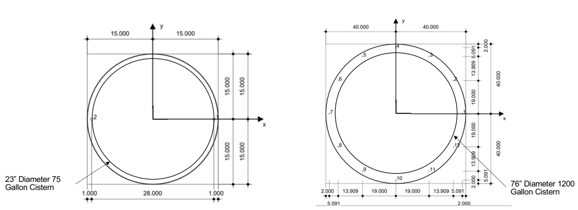
SEISMIC BRACING FOR TANKS



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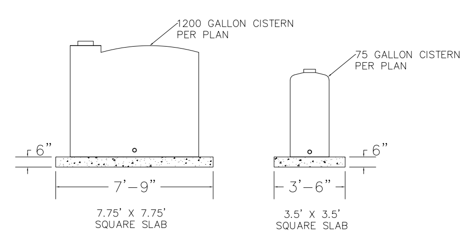
TANK FOUNDATION DESIGN



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DESIGN ALTERNATIVES CONSIDERED

Below Ground Storage
- Pros: Additional rainwater storage capacity, greater planting area for community
- Cons: No visibility/lack of a learning element to encourage guests to pursue their own rainwater collection storage at home.

Infiltration BMPs
- Pros: Recharges groundwater, prevents flooding, increases biodiversity, low maintenance.
- Cons: LAEV goal is to maximize rainwater harvest and use potential.

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RUNOFF HARVESTING FUTURE RECCOMENDATIONS

- Cistern sizing based on climate projections.
- Site runoff collection
- Rebates and Incentives
  - SoCal Water$mart
  - Rainplan Green Spending Advance

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AQUAPONICS SYSTEM

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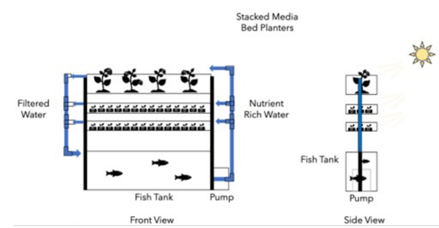
DESIGN LAYOUT AND PROCESS DIAGRAM



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FISH, PLANT, AND MEDIA SELECTION

BLUE TILAPIA	COMMON "NUTRIENT HUNGRY" PLANTS	LAVA ROCK
• Low maintenance • Tolerant to crowding, temperature variation, and high levels of potassium • 3-4 lbs	• Basil • Tomatoes • Lettuce and Cabbage • Kale • Broccoli • Microgreens	• Angular shape • Neutral pH • High porosity • Low cost

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BENEFITS OF MICROGREENS

- QUICK TO HARVEST
- HIGH IN NUTRIENTS
- EASY TO GROW
- IN HIGH DEMAND

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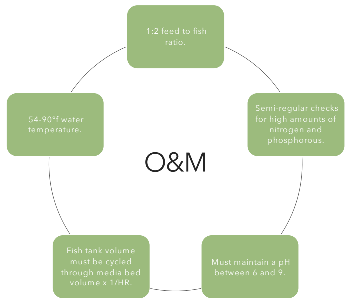

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AERATION

REQUIREMENTS:

- Warm water fish: 5mg/L of DO to maintain good health
- Plants: 4-12mg/L of DO for respiration

ASSUMPTIONS:

- 6" medium pore diffusers (0.5 cfm)
- 1:2 oxygen to feed ratio
- 0.01 SOTE, Standard Oxygen Transfer Efficiency rate

Aerator Size	Air Stone Size	Number of Air Stones
9000 L/H	6" medium pore diffusers	7

Calculate the amount of oxygen needed for the system based upon the daily feed rate.

Determine the number of diffusers/air stones to supply the amount of oxygen needed.

Quantify the minimum CFM produced by an air pump that will supply the oxygen diffusion rate at the depth of the fish tank.

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HYDRAULICS DESIGN

Tank Sizing Considerations:

1. 1:1 fish tank to grow bed ratio
2. 3:1 tank to fish ratio
3. Media beds sized per plant height/growth requirements

	Volume (gallons)	Area (ft^2)
Fish Tank	270 (holds 240)	18
Microgreens Media Beds (x2)	51	18
Fruit/Vegetable Media Beds (x1)	135	18
Tank Type	**Depth/Bed Height (ft)**	**Total Headloss (ft)**
Fish Tank	2	0
Microgreens Media Bed 1	0.375	2.375
Microgreens Media Bed 2	0.375	3.75
Fruit/Vegetable Media Bed	1	5.75

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HYDRAULICS DESIGN

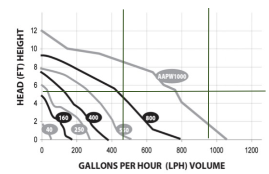
REQUIREMENTS:

- Cycle the fish tank volume through the media bed volume at least 1-2 times/hour
- Pipes must be no greater than ¾" to avoid fish passing through the system

ASSUMPTIONS:

- The media beds are made up of approximately 40% water and 60% media
- 15-minute timer system (5 min on, 10 min off)
- Average pressure of about 20-100psi and 6-12ft/s flow velocity

ACTIVE AQUA SUBMERSIBLE PUMP COMPARISON CHART



Pump Size	Pipe Size
800-1000 GPH	½-¾"

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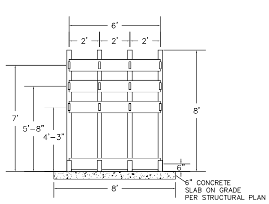
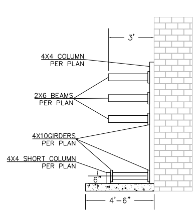
FRAMING DESIGN



Front View



Side View

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STRUCTURAL FRAMING SIZES

Structural Frame Material Details				
Member Name	*Quantity*	*Nominal Dimensions Selected (ft)*	*Length (ft)*	*Material*
Tall Columns	4	4 by 4	8	No. 1 Douglas Fir Larch
Short Columns	4	4 by 4	0.5	No. 1 Douglas Fir Larch
Beams	16	2 by 6	3	No. 1 Douglas Fir Larch
Girders	5	2 by 10	6	No. 1 Douglas Fir Larch

Structural Sheathing Material Details				
Material	*Area (sq ft)*	*Thickness (in)*	*Minimum Nail Bearing Length in Framing and Blocking (in)*	*Panel Nail Edge Spacing (in)*
Plywood Sheathing Structural Panel	72	3/8	1.375	6

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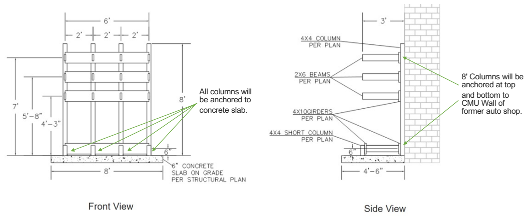
SEISMIC BRACING AND FOUNDATION



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DESIGN ALTERNATIVES CONSIDERED

Nutrient Film Technique (NFT) or Raft Deepwater Culture (DWC)
- Pros: High yield of crops, efficient use of space with vertical design, easy set-up, low water usage
- Cons: Requires constant monitoring, expensive, limited plant variety (leafy greens and herbs)

Peristaltic Pump
- Pros: Positive displacement, meter constant flow regardless of head, less energy required to start and stop pump (continuous operation)
- Cons: Constant operation not optimal for plant/fish health and growth

Simply Supported Beams to Support Media Beds
- Pros: Allows for smaller beam sizing
- Cons: Decreases ease of harvesting, less aesthetically pleasing

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AQUAPONICS FUTURE RECCOMENDATIONS

- Manual paddlewheel for visitor interaction

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UTILITIES, CEQA CHECKLIST, COSTS

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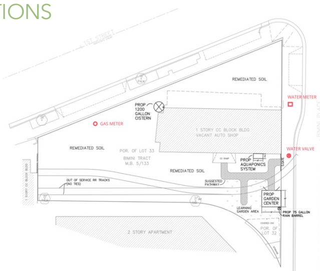
SITE UTILITIES CONNECTIONS

- Existing services for the retrofitted auto shop/community hub
- Pumps and Garden Education Center lighting must be connected to power
- TBD by an electrical engineer



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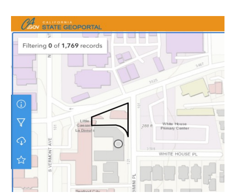
CEQA CHECKLIST – MAJOR ITEMS

GEOLOGY AND SOILS

"Less than significant impact with mitigation incorporated."

- Boring Log reports were obtained from a site 0.3 mi from LAEV. The blow counts and a "deep" water table indicate that the soil is likely not susceptible to liquefaction, landslide, lateral spreading, or collapse.
- Additionally, the site does not fall within a liquefaction zone on the CGS Seismic Hazards Program Map.
- Project elements will be seismically braced in compliance with relevant building codes.



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PROJECT COST ESTIMATE

Category	Total Cost
Structural Costs	$ 6,500.00
Rainwater Harvest and Use System	$ 2,500.00
Total Aquaponics Cost	$ 4,500.00
Sitwork	$ 4,000.00
Total O&M Cost	$ 1,500.00
Total Construction Cost	**$ 19,000.00**

**Not Included: Site restoration (asphalt removal, soil remediation, erosion control measures, precise grading), lighting and electrical, solar panel installation costs.*

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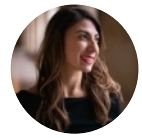
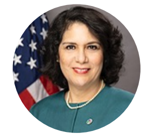
ACKNOWLEDGEMENTS

Negin Tauberg
Ph.D., P.E.



Brianna Pagán
Ph.D.



Maria Elena-Giner
Ph.D., P.E., MBA

THANK YOU TO OUR AMAZING MENTORS!

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ACKNOWLEDGEMENTS

LOS ANGELES ECO-VILLAGE

THANK YOU TO LOIS ARKIN, GIDEON SUSMAN, JAMES JEON, AND THE LAEV COMMUNITY!

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SONGS AT LOS ANGELES ECO-VILLAGE

KENDALL GILBERT, KRISTIN HERNANDEZ, GIANNA MORELLI, & MARINA MIRELES-RIOS

LMU|LA Loyola Marymount University
Department of Civil & Environmental Engineering

BACKGROUND

The Los Angeles Eco-Village (LAEV) is a 40-tenant co-op housing community focused on sustainable and economic cooperative living. The community consists of the two blocks of Bimini and White House Place located in the north end of the Wilshire Center area of Los Angeles. In 2016, CRSP, the nonprofit developer of the LAEV, acquired a quarter acre property known as Songs, formerly an auto shop, on the north end of the neighborhood. The property is classified as a Brownfield and significant work has already been done to address soil remediation and retrofit of the existing auto shop structure. The LAEV wishes to transform and redevelop this new acquisition into a thriving multipurpose community hub for tenants and visitors seeking to learn about sustainable urban living.

PROJECT OVERVIEW

After several meetings with LA eco village founder Lois Arkin, and other LA eco village members, we summarized the immediate needs and desires of the community into four main objectives to guide our design.

01 The design should cultivate new, highly sustainable, and resilient ideas on urban living.

02 The design should incorporate educational elements to inspire visitors and tenants to live more sustainably.

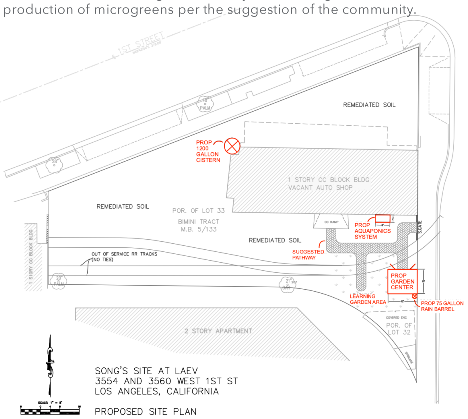
03 The design should fit within the schedule and scope of existing community plans.

04 The design should minimize costs.

The area on the Southeast portion of the site has been reimagined and designed as a 'Learning Garden' to be equipped with a 120 square foot structure that serves as a multi-purpose Garden Education Center. The proposed Learning Garden space will aim to satisfy LAEV's expressed interest in developing a garden space with potential for community engagement and learning opportunity.

This design proposal also includes a rainwater collection, storage, and use system for the site. It is the goal of the client to collect and use as much on-site runoff as possible to improve the sustainable practices of the community. Harvesting on-site runoff for non-potable uses is a resilient and accessible practice, and it is a goal of the community to maximize collection and use on site while inspiring visitors and other members of the community to adopt similar practices.

The current aquaponics system serves as an additional source of produce for the community and is used to educate and inspire visitors to try constructing their own aquaponics systems. Eco-lions engineering proposes an expanded aquaponics system to include live fish as the source of nutrients and the growing space expanded by implementing a stacked media bed design. The new system is designed to include production of microgreens per the suggestion of the community.



LEARNING GARDEN EDUCATION CENTER

The Garden Education Center (GEC) is designed as a 120 square foot wood-framed structure with a 4:1 mono-slope roof. The minimum and maximum heights of the structure are 10 feet and 14-feet respectively. The building is designed to serve the residents of LA Eco-Village and visitors as a shared space to teach the basics of urban agriculture. Occupants of the building can use the space as a welcome center for scheduled tours, to host educational sessions or to store seedlings and newly planted plants. The surrounding area is designed as an outdoor garden space that can be used by residents and visitors for gardening workshops.

STRUCTURAL DESIGN PROCEDURE

1. *Make material selection and determine preliminary structural member dimensions based on conceptual design.*
2. *Determine Loads including Dead, Live, Wind, Seismic, Snow and Rain Loads per ASCE 7-16.*
3. *Select trial sizes for each member.*
4. *Check member capacities such as shear, bending, axial compression and deflection per LRFD and NDS regulations.*
5. *Compare member capacity to member demand. Resize member if necessary.*

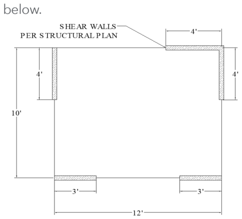
Material Specifications

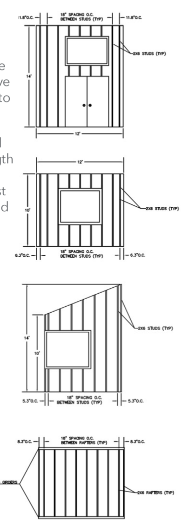
Member	Material Selection
Roof Rafters	2x6 No. 1 Douglas Fir
Roof Girders	4x10 No. 1 Douglas Fir
Wall Studs	2x6 No. 1 Douglas Fir
Floor Joists	2x6 No. 1 Douglas Fir
Non-Structural Sheathing	0.375" Plywood
Shear Wall	0.375" Plywood
Seismic Hold Down	Steel Heavy Tension Tie
Footing	Reinforced Concrete

Load Summary	Weight (psf)
Dead (D)	13.5
Live (L)	0
Rood Live (Lr)	19.2
Rain (R)	0
Snow (S)	0
Wind (W)	11.97
Seismic (Ev)	4.37
Seismic (Eh)	8.14
Seismic (Emh)	18.78
Seismic (Em)	14.41

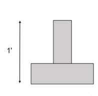
SEISMIC DESIGN

The seismic base shear was determined to be the governing lateral force on the structure. The seismic base shear was determined through the ELF procedure from ASCE 7-16 guidelines. Since the site does not have soil reports, the site class was conservatively assumed to be site class D for the seismic analysis. A seismic force resisting system of structural wood shear walls was selected for the structure. These shear walls were sized based on NDS 2018 height to base ratios, shear strength and deflection. The shear walls will be anchored to the foundation using steel heavy tension ties, sized to resist the resulting tension and compression force couple and deflection. The shear wall location is shown in the plan view below.





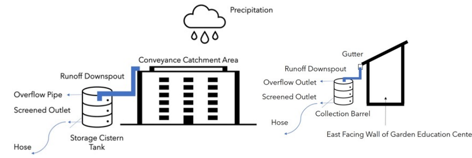
FOUNDATION DESIGN



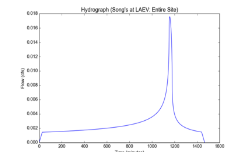
The soil properties were approximated using the nearest available boring data for the foundation. The foundation will be a continuous strip footing sized at a depth of 1 ft, width of 1 ft and thickness of 0.5 ft based on IBC 2018 guidance. The footing will be reinforced with no. 5 rebar.

ECOLIONS ENGINEERING

RAINWATER COLLECTION, STORAGE, AND USE



The total site runoff was calculated for the site using the Modified Rational Method through the LA County HydroCalc Software according to the 85th percentile, 24-hour rain event for the 100-year storm. The peak flow for the site is approximately 0.0176 cubic feet per second as shown in the runoff hydrograph in the figure below The total rainwater collection volume applied only to runoff from the roof areas of the existing auto shop building roof and proposed shed roof. The total site runoff and total collection volume are shown in the table below.



	Cubic Feet	Gallons
Total Site Runoff	237.1	1744.6
Rainwater Collection Volume	163.8	1225.0

	Cubic Feet per Second (cfs)	Gallons Per Minute (gpm)
Peak Flow Rate	0.0176	7.90

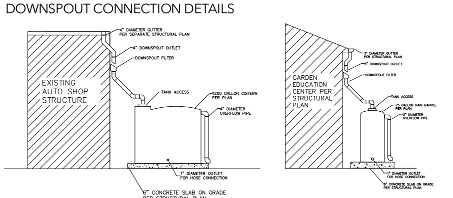
The collection storage and use system was designed to help meet the desire of the LAEV community to maximize on site water use. The rainwater collected and stored from the structure roofs can be used for onsite irrigation in the learning garden, diversity garden, or the LAEV residential site next door. Additional non-potable uses include replenishment of the aquaponics system and the suggested onsite vegetable washing station.

The final tank capacities were determined based off of the design runoff volume for the roofs of the Autoshop and garden structure. The dimensions for the selected polyethylene tanks from ProTank.com are shown below. Both tanks will connect to the designed downspouts with PVC piping as shown in the details below. Each tank sits on a concrete slab and is seismically braced in compliance with relevant design codes.

	Rainwater Collection Volume (gallons)	Tank Size (gallons)
Songs Building Roof	1192.6	1200
Shed Roof	72.8	75

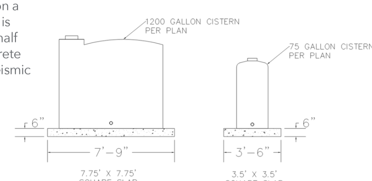
Tank Size (gallons)	Diameter (in)	Height (in)
1200	76	66
75	23	50

DOWNSPOUT CONNECTION DETAILS

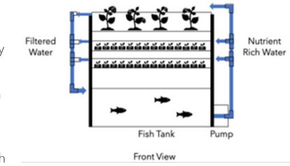


TANK FOUNDATIONS

Each tank sits on a steel plate that is anchored to a half foot thick concrete slab to resist seismic lateral forces.



IMPROVED AQUAPONICS SYSTEM



Right is the process diagram of the newly designed, vertical stacked aquaponics system. The stacked design provides opportunity for greater growth area and walk space around the community hub. The system operates as a combination of aquaculture and hydroponics. It is a closed-loop system in which the fish are raised in a tank and their waste produces ammonia. This nutrient rich water is then filtered through the media beds, where bacteria converts it to nitrite, then nitrate. This serves as a fertilizer for the plants in the system. Additionally, as the water passes through the media bed, solids are filtered out and provide area for bacteria to grow and maintain a stable pH level in the system. Finally, the fresh water is returned to the fish tank to repeat the process.

SIZING AND DIMENSIONS

	Volume (gallons)	Area (ft^2)
Fish Tank	270 (holds 240)	18
Microgreens Media Beds (x2)	51	18
Fruit/Vegetable Media Beds (x1)	135	18

Tank Type	Depth/Bed Height (ft)	Total Headloss (ft)
Fish Tank	2	0
Microgreens Media Bed 1	0.375	2.375
Microgreens Media Bed 2	0.357	3.75
Fruit/Vegetable Media Bed	1	5.75

Another important element for system maintenance is monitoring DO levels for fish and plant health. The oxygen required for the system was calculated with the assumption of 6" medium pore diffusers, which utilize a 0.01 standard oxygen transfer efficiency rate. Additionally, this was determined based on the assumption that there would be a 1:2 oxygen to feed ratio. The number of air stones were determined by the weight of feed per hour and the weight of oxygen per hour. And finally, the air pump was sized based on the number of stones required, and their corresponding cfm. This was also multiplied by a safety factor of 1.5 to ensure adequate aeration.

The aquaponics pump was sized with three main considerations:

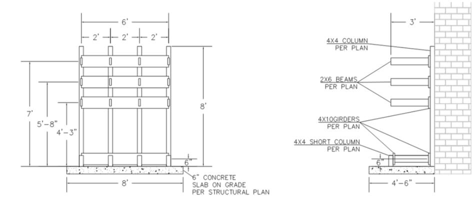
- Distance the water is lifted against gravity
- Volume of water to fill the grow beds in the amount of time the pump is running
- Fish tank turnover

The pump was sized to cycle the tank volume through the media bed volume at least 1-2 times per hour, on a 15-minute timer system running 5 minutes on

Pump Size	Pipe Size
800-1000 GPH	½-¾"

Aerator Size	Air Stone Size	Number of Air Stones
9000 L/H	6" medium pore diffusers	7

STRUCTURAL FRAMING PLAN



Structural Frame Material Details

Member Name	Quantity	Nominal Dimensions Selected (ft)	Length (ft)	Material
Tall Columns	4	4 by 4	8	No. 1 Douglas Fir Larch
Short Columns	4	4 by 4	0.5	No. 1 Douglas Fir Larch
Beams	16	2 by 6	3	No. 1 Douglas Fir Larch
Girders	5	2 by 10	6	No. 1 Douglas Fir Larch

Structural Sheathing Material Details

Material	Area (sq ft)	Thickness (in)	Minimum Nail Bearing Length in Framing and Blocking (in)	Panel Nail Edge Spacing (in)
Plywood Sheathing Structural Panel	72	3/8	1.375	6

APPENDIX L: Ethics Presentation

ECOLIONS ENGINEERING

ETHICS CASE STUDY PRESENTATION

Prepared by Kendall Gilbert, Kristin Hernandez, Gia Morelli, & Marina Rios

1

ECOLIONS ENGINEERING

CASE 20: CONFIDENTIAL REPORT FINDINGS

- Sara, an engineering intern (EI) who has passed her FE, is assigned to inspect the structural integrity of an apartment complex that a client is looking to sell. **She is informed that the client requires the structural report to remain confidential.**
- Sara performs a site inspection and notices no structural issues, but she does notice **potential electrical hazards.**
- She verbally informs the client and writes a vague report about the safety hazards she observed, which is signed off by her supervisor. Later she finds out that **the client did not inform the occupants nor the buyer about the potential hazard.**

Sara moves on to other projects without informing the authorities or her supervisor.

2

ECOLIONS ENGINEERING

CASE 20: CONFIDENTIAL REPORT FINDINGS

Discuss options Sara could have taken. Did she have an obligation to inform the local authorities of the electrical hazards, considering she is a civil engineering intern and not an electrical engineer?

3

ECOLIONS ENGINEERING

POINTS OF ISSUE

1. **Society.** As an EI, Sara is obligated to "first and foremost, protect the health, safety and welfare of the public" (ASCE Code of Ethics)
   - Sara discovers that the client is neglecting the electrical hazards that pose a threat to the safety to residents and prospective buyers (society)
   - Sara fails to "report misconduct to the appropriate authorities where necessary to protect the health, safety and welfare of the public" (ASCE Code of Ethics Canon 1i)
2. **Clients and Employees.** Sara did not clearly report the electrical hazards on the apartment complex site to her employers and failed to present the consequences of the electrical hazards to the client.
   - "...with reluctance, Sara verbally informed the client about the problem and made an oblique reference to the electrical deficiencies in her report"
   - Failed to "present clearly and promptly the consequences to clients and employers if their engineering judgment is overruled where health, safety, and welfare of the public may be endangered;" (ASCE Code of Ethics Canon 1c)

4

POTENTIAL ACTIONS

1. Sarah could refer to the ASCE code of Ethics to assist her decision-making process
2. Sarah could have a conversation with her supervisor to inform them of the consequences of ignoring the safety concerns, who is likely much more experienced in engineering ethics.
3. Sarah could inform the client more clearly of the potential consequences of ignoring the safety concerns and not informing the tenants or the buyer.
4. Sarah could go against the agreement of confidentiality and report to the information and safety concern directly to the proper authorities.
5. Sarah could continue to do nothing.

5

RECOMMENDED ACTION

- Sarah should immediately refer to the ASCE code of ethics to help inform her actions.
- Sarah should have a conversation with her supervisor to inform them clearly about the nature of the electrical deficiencies.
  - "present clearly and promptly the consequences to clients and employers if their engineering judgment is overruled where health, safety, and welfare of the public may be endangered" (ASCE Code of Ethics Canon 1c)
- Sarah should ensure that the client understands the potential health and safety concerns of the electrical deficiencies.
- Sarah should inform the authorities about the potential electrical deficiencies if her employer and client still do not choose to take action.
  - "report misconduct to the appropriate authorities where necessary to protect the health, safety, and welfare of the public" (ASCE Code of Ethics Canon 1d)
  - "Disclosures made upon discovering a hazard within the licensee's field of professional expertise which may threaten the health, safety, and welfare of the public" (CA Code of Professional Conduct Rule 475)

6

Sources

- ASCE Code of Ethics
- California Professional Code of Conduct Rule 475

7

APPENDIX M: Summary of Brownfield Investigation

SUMMARY OF BROWNFIELD INVESTIGATION AND REMEDIATION TACTICS

3554 WEST FIRST STREET, LOS ANGELES, CA

The Songs at LAEV site has been designated as a Brownfield by the United States Environmental Protection Agency Region 9. CRSP and LAEV plan to redevelop the site for community use including potential for commercial and residential use. In 2016, EFI Global, Inc. performed a Phase I Environmental site assessment at the Songs site.

In 2017, Weston Solutions, Inc performed a Phase II Targeted Brownfield's Assessment and an Analysis of Brownfields Cleanup Alternatives. Afterwards the LAEV partnered with the Soil Biogeochemistry Group at U.C. Riverside to research community-accessible remediation options for the site. The partnership conducted a study throughout 2021 and 2022 to determine the efficacy of fungi for absorbing heavy metals in conjunction with other remediation techniques like phytoextraction. The results of this study will be obtained from the client.

As of January 2023, the southwest portion of the site is being used for soil remediation research. The scope of work for this project does not involve selection or design of remedies. All soil remediation is to be completed by the time of implementation of elements included in this design report.

APPENDIX N: Boring Log Data for 3560 Beverly Blvd

BORING LOG

Client Shell Oil Products US

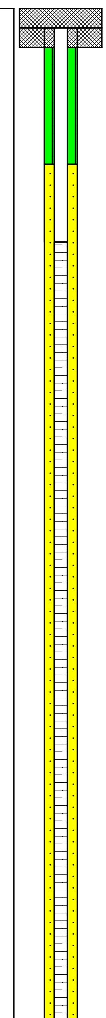
Project Number SCA3560B1A

Well No.
MW-1

Address:	Drilling Date(s): **09/03/09**	Boring diameter (in.): **10"**	Casing Material: **Sch 40 PVC**
3560 Beverly	Drilling Company: **BC2**	Sampling Method: **Cal MOD SS**	Screen Interval: **6' - 26' bgs**
Los Angeles, CA	Drilling Method: **HSA**	Well Depth (ft.): **26'**	Screen slot size: **0.010**
Logged By: **EB**	Boring Depth (ft): **26'**	Casing Diameter (in.): **4"**	Sand Pack: **#2/16**

Depth (ft.)	Water Level	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)
0				CONCRETE: ~5" Concrete Cap.	
				ML: Sandy SILT, very fine sand, light brown, dry.	
5					
				Airknifed to ~7 feet bgs on 09/02/09.	
10		41	67%	SM: SAND with silt, very fine sand, light brown, medium stiff, damp.	3.8
		43	67%	SM: (as above, silt decreases)	
		45	50%	SP: Poorly-graded SAND, damp.	
15		49	67%	SP: Poorly-graded SAND, fine grained, trace medium sand, damp.	1.4
	▽	39	100%	SP: (as above, wet)	
		30	100%	SP: (as above)	
20		43	83%	CL: CLAY, gray, dry.	38.5
		31	75%	SP: Poorly-graded SAND, tarry dark brown, fine grained, micaceous.	
				SP: (as above)	
		50	100%	SP: (as above)	
25		77	67%	SP: Poorly-graded SAND, fine grained, light brown, dry.	24.6
				Bottom of boring = 26 feet bgs. Note: Sampled to 26.5 feet bgs.	
30					

Well Completion



BORING LOG

Client Shell Oil Products US
Project Number SCA3560B1A

Well No.
MW-2

Address:	Drilling Date(s): **09/04/09**	Boring diameter (in.): **10"**	Casing Material: **Sch 40 PVC**
3560 Beverly	Drilling Company: **BC2**	Sampling Method: **Cal MOD SS**	Screen Interval: **6' - 26' bgs**
Los Angeles, CA	Drilling Method: **HSA/LAR**	Well Depth (ft.): **26'**	Screen slot size: **0.010**
Logged By: **TT**	Boring Depth (ft): **30'**	Casing Diameter (in.): **4"**	Sand Pack: **#2/16**

Depth (ft.)	Water Level	Soil/Rock Graphic	Sampled Interval	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)	Well Completion	Depth (ft.)
0						ASPHALT: ~4" Asphalt Cap.			0
						ML: Sandy SILT, brown, fine grained, tight, dry.			
5									5
						Airknifed and waterknifed to ~7 feet bgs.			
10				34	100%	SP: Poorly-graded SAND, olive gray, very fine to fine grained, trace medium sand, trace silt, damp to dry.	1.1		10
15				30	100%	SP: (as above, damp)	0.0		15
20				44	100%	SM: Silty SAND, brown to dark brown, 25% silt, trace clay.	36.5		20
25				53	100%	SM: Silty SAND, black, contains natural tar/oil, trace clay, damp.	32.9		25
30				38	100%	SM: (as above, damp)	11.1		30
						ML: Sandy SILT, gray, 25-30% very fine grained, brittle, damp to dry.			
						Bottom of boring = 30 feet bgs. Note: Sampled to 31.5 feet bgs.			
35									35

BORING LOG

Client **Shell Oil Products US**

Project Number **SCA3560B1A**

Well No.
MW-3

Address:	Drilling Date(s): **09/03/09**	Boring diameter (in.): **10"**	Casing Material: **Sch 40 PVC**
3560 Beverly	Drilling Company: **BC2**	Sampling Method: **Cal MOD SS**	Screen Interval: **6' - 26' bgs**
Los Angeles, CA	Drilling Method: **HSA**	Well Depth (ft.): **26'**	Screen slot size: **0.010**
Logged By: **EB**	Boring Depth (ft): **35'**	Casing Diameter (in.): **4"**	Sand Pack: **#2/16**

Depth (ft.)	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)
0			ASPHALT: ~4" Asphalt Cap.	
			ML: Sandy SILT, brown, fine grained, tight.	
			Waterknifed to ~8 feet bgs on 09/03/09.	
10	38	67%	SP: SAND, fine grained sand with trace coarse sand trace silt, dry.	0.2
15	42	100%	SP: (as above)	6.6
20	56	83%	SM: SAND, dark brown, very fine grained, medium tight, tarry.	56.7
	67	75%	SM: (as above, with silt)	
	76	100%	SM: (as above, silt decreasing)	
25	53	67%	SM: (as above, silt increasing, trace coarse sand)	254
	59	100%		
	73	100%	SM: (as above)	
30	49	100%	CL: CLAY, dark brown, dry.	58.9
	59	100%	SP: Poorly-graded SAND, dark brown, fine grained, trace silt, dry.	
	73	100%	SP: (as above, silt with tar, dark brown, dry)	
35	75	100%	SP: Poorly-graded SAND, dark brown, fine grained, trace silt, dry.	19.7
40			Bottom of boring = 35 feet bgs. Note: Sampled to 36.5 feet bgs.	

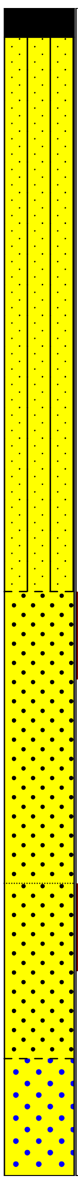
BORING LOG

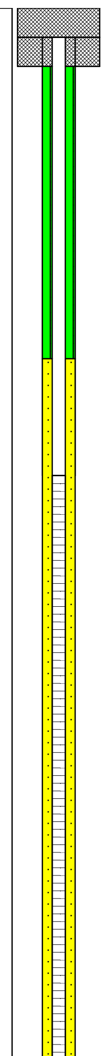
Client **Shell Oil Products US**

Project Number **SCA3560B1A**

Well No.
MW-4

Address:	Drilling Date(s): **09/04/09**	Boring diameter (in.): **10"**	Casing Material: **Sch 40 PVC**
3560 Beverly	Drilling Company: **BC2**	Sampling Method: **Cal MOD SS**	Screen Interval: **8' - 18' bgs**
Los Angeles, CA	Drilling Method: **HSA**	Well Depth (ft.): **18'**	Screen slot size: **0.010**
Logged By: **TT**	Boring Depth (ft): **18'**	Casing Diameter (in.): **4"**	Sand Pack: **#2/16**

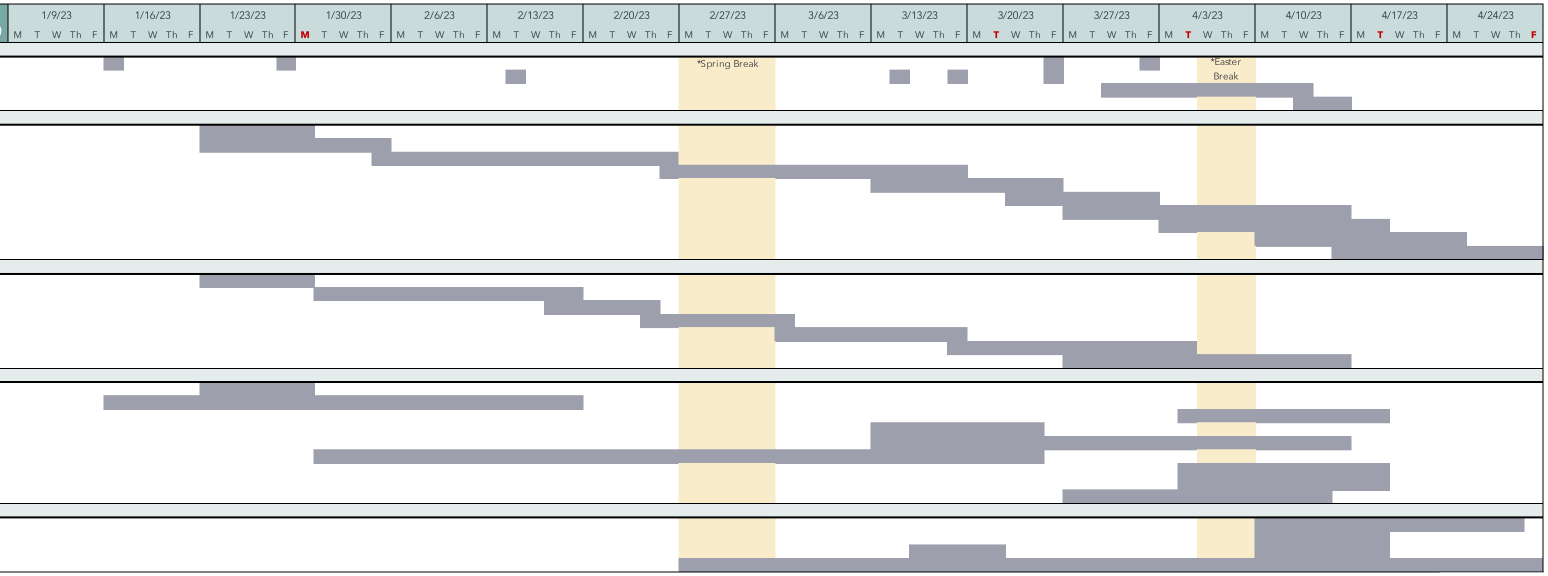




Depth (ft.)	Water Level	Soil/Rock Graphic	Sampled Interval	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)	Well Completion	Depth (ft.)
0						ASPHALT: Asphalt Cap.			0
						SM: Silty SAND with gravel, brown, fine to coarse grained, tight.			
5									5
						Airknifed to ~7 feet bgs on 09/03/09.			
10				40	100%	SP: Poorly-graded SAND, olive green, fine grained, trace silt, damp.			10
15				46	100%	SP: (as above, olive green to yellowish orange, damp)			15
						SANDSTONE: SANDSTONE with natural oil.			
						Refusal at 18' bgs. Note: Sampled to 16.5 feet bgs.			
20									20

APPENDIX O: Timesheets

Task Name	Start Date	End Date	Duration (days)	Percent Complete (%)
Site Planning				
Client Meetings	N/A	N/A	N/A	100%
Mentor Meetings	N/A	N/A	N/A	100%
Civil3D Site Plan	29-Mar	12-Apr	14	100%
Earthwork Calculations	12-Apr	14-Apr	2	100%
Learning Garden & Garden Education Center				
Conceptual Design	23-Jan	30-Jan	7	100%
Materials Research	23-Jan	3-Feb	11	100%
Load Design	3-Feb	24-Feb	21	100%
Member Sizing	24-Feb	10-Mar	14	100%
Seismic Calculations	13-Mar	24-Mar	11	100%
Seismic Bracing	22-Mar	31-Mar	9	100%
Foundation Design	27-Mar	14-Apr	18	100%
Shear Wall Design	3-Apr	18-Apr	15	100%
Base Shear Analysis	10-Apr	24-Apr	14	100%
Sketchup Model	14-Apr	28-Apr	14	100%
Rain Water Collection and Use				
Conceptual Design	23-Jan	30-Jan	7	100%
Hydrology Study	31-Jan	17-Feb	17	100%
Feasibility Study	16-Feb	23-Feb	7	100%
Tank Sizing	23-Feb	6-Mar	11	100%
Connection Design	6-Mar	17-Mar	11	100%
Seismic Bracing	17-Mar	4-Apr	18	100%
Foundation Design	27-Mar	14-Apr	18	100%
Aquaponics System				
Conceptual Design	23-Jan	30-Jan	7	100%
Research	16-Jan	17-Feb	32	100%
Material Selection	4-Apr	18-Apr	14	100%
Aeration Design	13-Mar	24-Mar	11	100%
Hydraulics Design	13-Mar	15-Apr	33	100%
Maintinence Requirements	31-Jan	24-Mar	52	100%
Structural Framing Design	4-Apr	18-Apr	14	100%
Seismic Bracing	4-Apr	18-Apr	14	100%
Foundation Design	27-Mar	14-Apr	18	100%
Report and Presentation				
CAD Details	10-Apr	28-Apr	18	100%
Slides	10-Apr	18-Apr	8	100%
Ethics Case Study	15-Mar	21-Mar	6	100%
Report Writing	27-Feb	28-Apr	60	100%



TEAM MEMBER	1/9/23	1/16/23	1/23/23	1/30/23	2/6/23	2/13/23	2/20/23	2/27/23	3/6/23	3/13/23	3/20/23	3/27/23	4/3/23	4/10/23	4/17/23	4/24/23	TOTAL HOURS
Gia Morelli	0	3	5	4	8	5	8	2	4	10	6	8	10	20	20	20	133
Kendall Gilbert	0	4	7	6	8	4	7	3	6	12	8	6	10	28	15	15	139
Kristin Hernandez	0	2	5	5	7	5	5	4	5	6	10	8	10	20	20	20	132
Marina Rios	0	2	4	4	6	4	6	3	8	4	8	10	12	25	20	16	132